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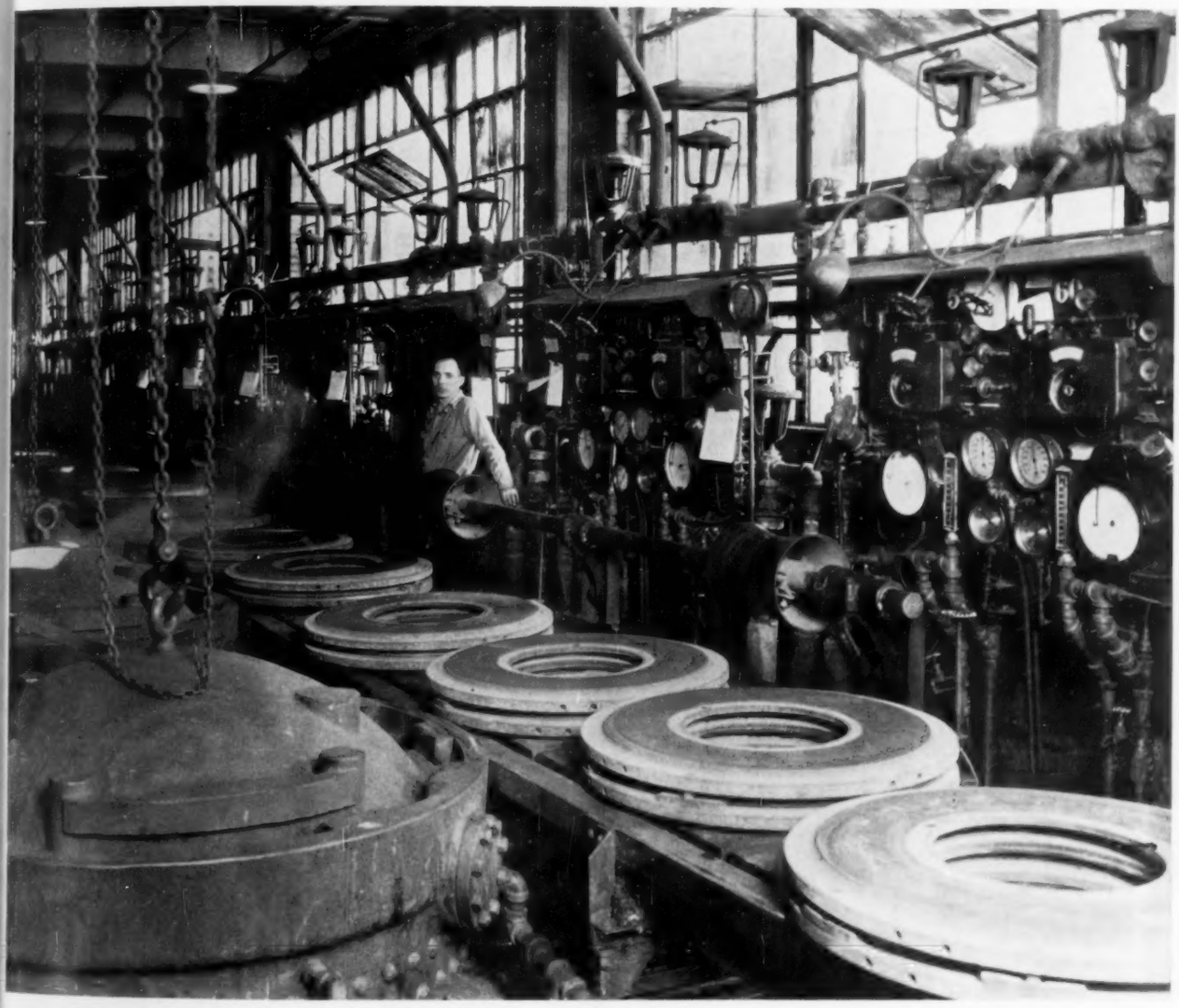
INSTRUMENTS

THE MAGAZINE OF MEASUREMENT AND CONTROL

VOLUME 5 JULY, 1932 NUMBER 7



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SEE PAGE A1

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5. **Book Reviews.** All new books in English, German and French, pertaining directly to measurements, inspection and control, or to closely allied subjects, are reviewed at length, especially for our readers, by competent specialists.

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8. **Editorial Comments** on current topics are designed to be constructive, helpful and forward-looking.

9. **Buyers' Guide.** The "Instruments Index" section is arranged for quick reference . . . and is referred to—with good results to all concerned.

10. **The Paid Advertisements** in almost every issue furnish not only food for thought but often grounds for action toward modernizing processes or plants.

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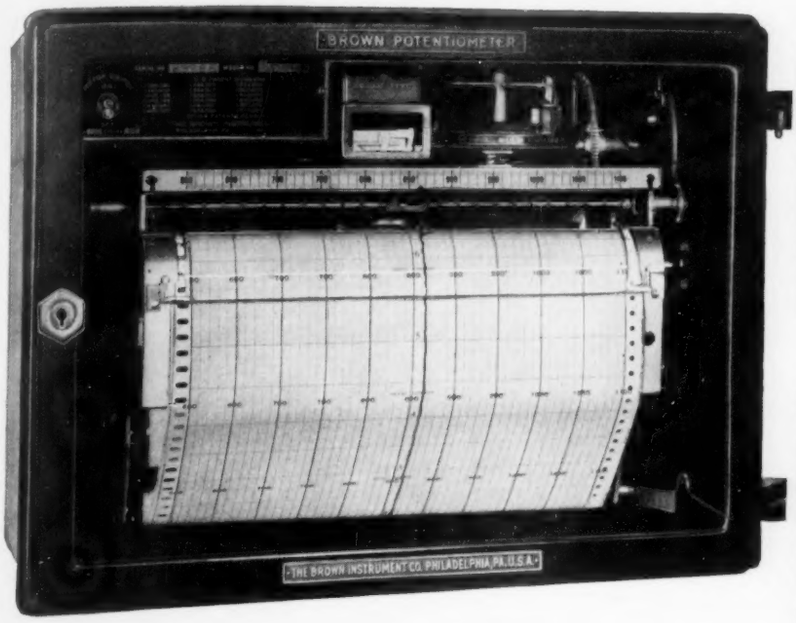
Greater Accuracy

...In Temperature Measurements



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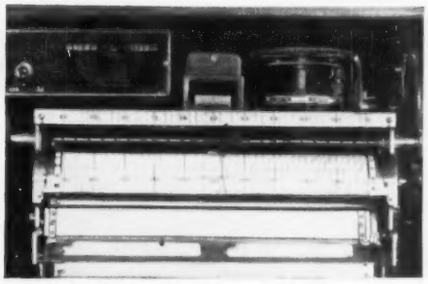
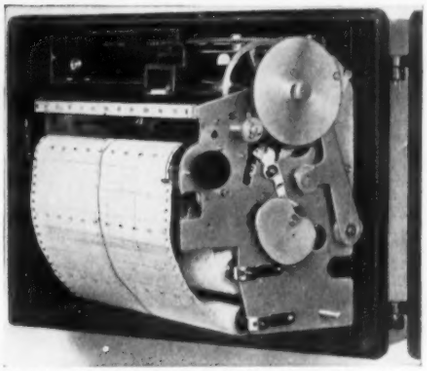
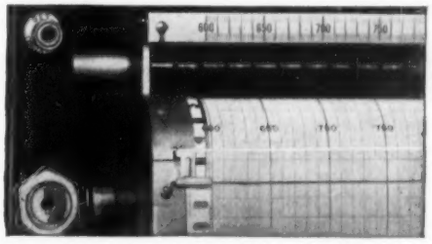


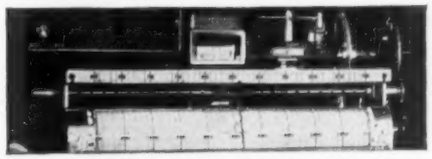
Humidity Compensator for Chart—Automatically compensates for possible errors caused by paper expansion and contraction.



Positive Non-Slip Driving Clutch—Rugged, positive and simple. Entire mechanism on swinging frame. Note also chart reroll.



Door Handle with Lock and Key for Use if Desired. Also Outside Control Setting—Control Temperature set by external knob.



Extra Wide (12") Chart gives close temperature readings.

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EDITORIAL COMMENT

In This Issue

◆ In the early years of the efficiency movement, before it became Scientific Management, the most-hated man in the world was the "speed-up" specialist who stood over a group of operatives, clocking their performances. Nowadays, **production records** are autographed by instruments and most workers are not only reconciled but contented. In his article, **O. J. Poupitch** describes a new and improved instrument which has achieved happy results at a Western Electric plant.

◆ Americans have reason to be proud of the results of research on **creep** of metals at various temperatures conducted by the Joint High Temperature Committee of the A.S.M.E. and A.S.T.M. and other bodies; but from time to time Europe comes across with an outstanding contribution. **Pomp** and **Enders** describe a new testing method and give some of their results.

◆ In this month's installment of his book on **Engine Indicators, Prof. DeJuhasz** takes apart the indicator, shows you its components one by one, and discusses each with a wealth of very interesting details.

◆ And our senior engineering editor, in his monthly installment, comes at last to the measuring elements of **rate-of-flow meters.** This particular article of **Major Béhar's** will immediately arouse interest on the part of his colleagues in the A.S.M.E. because it is the first time that a writer of his standing dares to tackle the problem of test meters versus commercial meters. Whether his outspoken solution will satisfy everyone is for the future to decide.

◆ ◆ ◆

The Cover

◆ Of all large-scale industrial processes the vulcanization of rubber tires and tubes is the one that involves the greatest number of instrumentally-controlled conditions. The human element has been removed from temperatures, pressures, sequencing and other factors. Therefore the view of a tire curing room at the B. F. Goodrich Rubber Co. is of interest.

Again, The Tariff!

UNITED STATES TARIFF COMMISSION
WASHINGTON

PUBLIC NOTICE

Investigation Ordered

OPTICAL INSTRUMENTS

INVESTIGATION No. 75 UNDER SECTION 336, TARIFF ACT OF 1930

The United States Tariff Commission on this 15th day of June, 1932, under and by virtue of the powers granted by law and pursuant to the rules and regulations of the Commission, and in accordance with Senate Resolution 227, 72d Congress, and Section 336(a)(2) of Title III of the tariff act of 1930, hereby orders an investigation, for the purposes of said Section 336, of the differences in costs of production of, and of all other facts and conditions enumerated in said section with respect to, the following articles described in paragraph 228 of Title I of said tariff act, namely,

Optical instruments of a class or type used by the Army, Navy, or Air Force for fire control and parts thereof,

being wholly or in part the growth or product of the United States, and of and with respect to like or similar articles wholly or in part the growth or product of competing foreign countries.

Ordered further, that all parties interested shall be given opportunity to be present, to produce evidence, and to be heard at a public hearing in said investigation to be held at the office of the Commission in Washington, D. C., or at such other place or places as the Commission may designate, on a date hereafter to be fixed, of which said public hearing prior public notice shall be given by posting a copy of the notice thereof for thirty days at the office of the Commission in the City of Washington, D. C., and at the office of the Commission at the Port of New York, and by publication in "Treasury Decisions," published by the Department of the Treasury, and in "Commerce Reports," published by the Department of Commerce, copies of which said publications are obtainable from the Superintendent of Documents of the Government Printing Office in Washington, D. C.

And ordered further, that public notice of said investigation shall be given by posting a copy of this order for thirty days at the office of the Commission in the City of Washington, D. C., and at the office of the Commission at the Port of New York, and by publication in said "Treasury Decisions" and in said "Commerce Reports."

I certify that this investigation was ordered by the United States Tariff Commission on the 15th day of June, 1932.

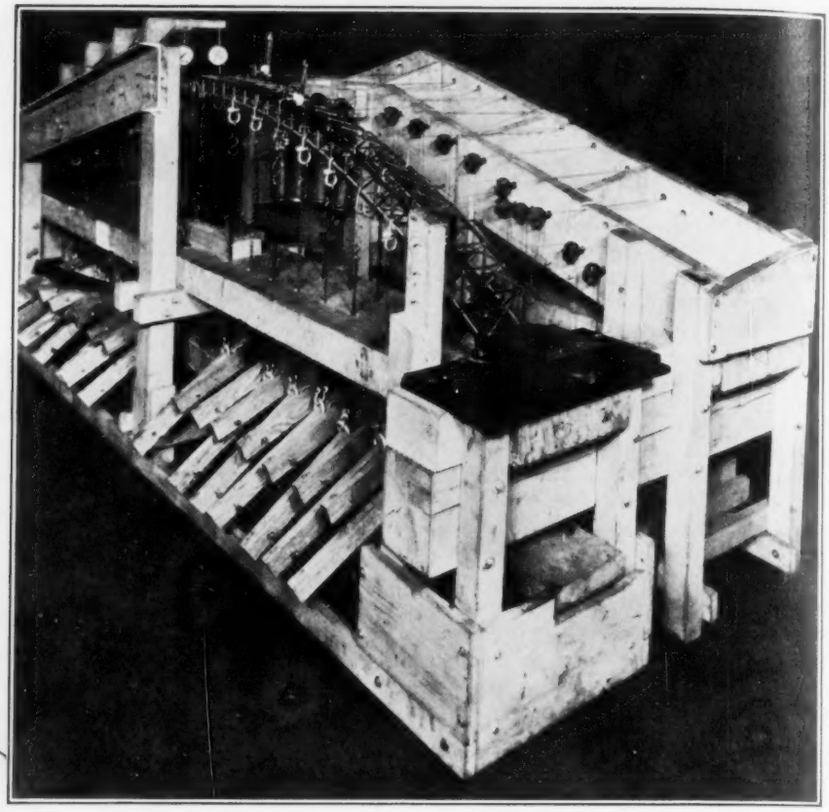
Sidney Morgan,
Secretary.

The editor does not see how the Army, Navy or Air Force can be in favor of decreasing the tariff on instruments for fire control. The need for instruments in National Defense is obvious and it therefore behooves these branches of the government to be present at the office of the Commission in Washington at the proper time. It is not logical to deliver the necessities required to protect our Nation from outside aggression into hands other than our own. If the time should come again—and it will—that we enter into another war, we should not have to depend upon even a friendly nation for the necessary weapons to effectively defend ourselves. We cannot now predict what countries will line up against us in the next conflict. If it should happen that the country on whom we depend for our defense instruments is among these it is obvious that our supply will be cut off—but even if that country is friendly, the instrument manufacturers of that country will not hesitate to make us pay an exhorbitant price for such instruments.

The U. S. Government has seen fit to assure the existence of companies able to construct aircraft by juicy mail contracts and the purchase of airships by the Navy. Why therefore should it not purchase the instruments required by its various departments from American manufacturers as an example of sound business judgment—first because this will insure work for American workmen and second because it will assure the purchase of such equipment at a *reasonable price* in time of necessity.

Finally, the American instrument manufacturer does not seek relief because foreign instruments are imported in threatening volume but because these instruments are being dumped at prices that domestic producers cannot meet and protect their employees from the lower wage standards of Europe.

. . . TESTING A BRIDGE



before it was Built

PIONEERING in the realm of the impossible—Southwark many times has offered the means of blazing new trails in scientific endeavor.

One able example was the designing of the Kill Van Kull span, the longest arch span in the world crossing New York Harbor from Bayonne, N. J., to Port Richmond, Staten Island.

Before a single member of the span was assembled—when the project was still on the drawing board—an exact scale model of the proposed central span was constructed from engravers brass. As a final check of the intricate mathematical calculations used in this span before the many tons of steel were actually fabricated, this miniature model was ingeniously arranged so that it could be subjected to loads and stresses simulating those the finished span was expected to encounter. One type of instrument of large importance in the minute measurements of movement in this model was the Huggenberger Tensometer.

The scope of Southwark mechanical testing instruments and equipment knows no bounds. From the largest universal testing machine in the world to diminutive devices that may be held in the palm of the hand—Southwark instruments may be found in the laboratories of leading technical schools, research institutes, government bureaus and progressive manufacturers. They may be found in the field—testing pipe, dams, bridges, power line towers, railroad cars, ships and aircraft while in motion, etc. Everywhere, they are performing an almost countless number of vital services to Industry, Transportation, Engineering and Research.

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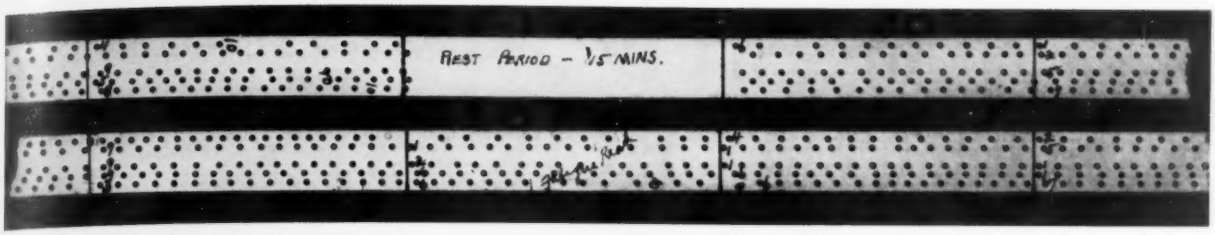


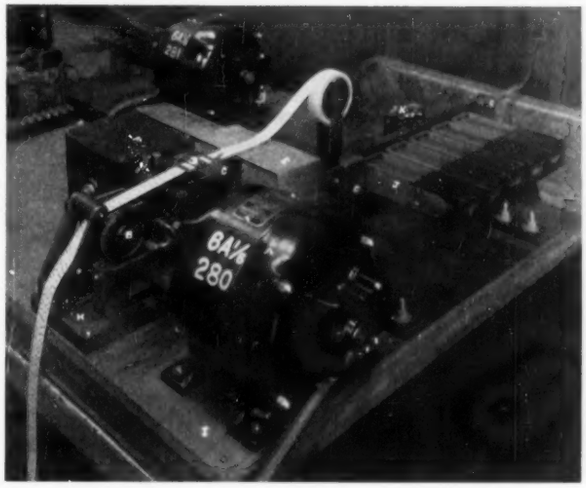
Novel Method of Production Timing

By O. J. POUPITCH

STUDIES of precise timing of production, subject to various changes in working conditions, such as rest periods, mid-morning lunches, shorter working hours, etc., were made in a novel manner by Mr. T. N. Whitehead of the Industrial Research Department of Harvard University, at the Hawthorne Works of the Western Electric Company.

The production is recorded on a wax impregnated paper tape "A" which is moved through a punching mechanism at a uniform rate of approximately ¼ in. per minute. The punching device is actuated upon completion of a finished unit which passes through a chute adjacent to the operator. In passing it lifts a flap door, which in turn closes the electric circuit operating the punch. Five operators engaged in this test are located in the so-called test room, each using a separate chute and a separate punching unit. Consequently a row of holes represent at any instant of the day's production the efficiency of the operator and the psychological effects of the day's happenings, etc.

The distances between the holes are accurately determined by the use of a length measuring machine, which is a standard Gaertner Scientific Corp. comparator, modified to suit the requirements of the test. The tape is placed in receptacle "F" on the machine, stretched across a glass plate mounted on the stage and attached to the winding device "B." The glass plate has a line engraved parallel to the motion of the carriage, against which the tape is aligned. The glass cover "C," which is



hinged, is brought into contact with the tape, holding it flat against the glass plate.

The settings are made with a microscope of adjustable magnification, fitted with rack and pinion focusing arrangement. The eye end has a specially ruled glass reticule, selected to permit quick and accurate settings.

The readings are made at the left end through a large magnifier on the two wheels "E," one giving full millimeters, and the other giving thousandths of millimeters,

(Continued on Page 168)

ACCELERATED METHOD FOR DETERMINING CREEP LIMIT

A. POMP* AND WALTER ENDERS*

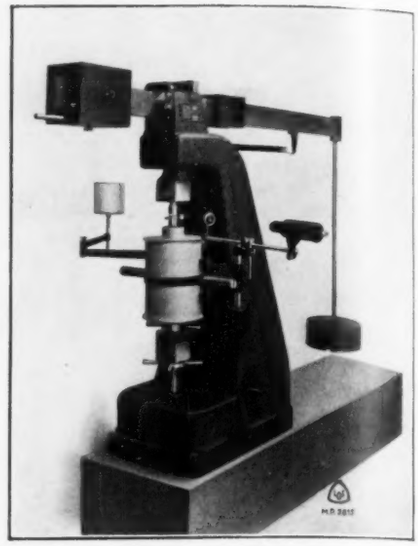


Fig. 1

In 1927, A Pomp and A. Dahmen gave a review[1] of the most important investigations made known in the literature up to 1926 on the behavior of steel (as well as of non-ferrous metals and alloys) under prolonged loading when heated. They concluded with an account of their own attempt at developing an accelerated test method for determining the creep limit of the steel at elevated temperatures. By creep limit is here meant that maximum loading at which an originally increasing elongation of the test specimen in the course of time comes to a stop, for when this maximum load is exceeded a continuing elongation of the material is encountered until it begins to fracture.

Since the determination of the actual creep limit consumes a great deal of time, under some circumstances requiring months and years, Pomp and Dahmen made the suggestion that, for practical purposes, as a creep limit determinable within a short time, that maximum loading be chosen at which, in a certain time after applying the load (3 to 6 hours), the rate of elongation does not exceed a certain fixed value (0.001%/hr.).

The fixing of an allowable limit of elongation rate at 0.001% per hour between the 3rd and 6th hour rests upon the assumption that, at testing temperatures up to about 500° C., and at the above named rate of elongation, a decrease of the elongation takes place within a comparatively short time, during the interval between the 3rd and the 6th hour.

The investigations described below were conducted for the purpose of checking up, with the aid of a perfected testing apparatus, the practical usefulness of the suggestion made by Pomp and Dahmen.

The construction of one of the creep testing machines used for these particular tests is illustrated in Fig. 1, and its schematic diagram in Fig. 2. Each of the four testing machines consists of a cast iron stand *a* (Fig. 2), the loading beam *b* with a leverage ratio of 1:20 between the grip-head *c* and the rod for supporting the load *e*. Weight beam, grip-head, and weight-supporting rod are pivoted on knife edges. For adjusting the weight beam to a horizontal level the lower grip *g* is arranged to be adjustable along the vertical by a simple device. By turning the positioning nut *H*, which is provided with ball bearings, one can, using a wrench about a meter long, effect an adjustment of the setting even at maximum loading.

A salt bath furnace serves to heat the test specimen, which remains in the bath all through the test. The container consists of a seamless tube of heat resisting Krupp NCT3 steel to which is welded a bottom of the same material. The heating is produced by a doubled-back (bifilar) winding of chrome nickel ribbon placed around the outside wall of the container. The winding is protected against contact with the container by insulation. The purpose of the double (bifilar) type of winding is to eliminate disturbing magnetic influences which, due to the use of alternating current, may give rise to vibrations in the test rod and in the measuring pointers.

The test rod is secured in the oven with the elongation rod and the measuring pointers in the manner to be noted from Fig. 3. For clamping the oven in the machine the usual ball bearings are provided on both clamping heads.

The Martens mirror extensometer was used to measure the elongation. Fig. 3 shows the mounting of the two pairs of measuring pointers on the test rod. Instead of reading the elongations that occurred during the experiment by the usual method of observation at intervals through a telescope, a continuous, automatically recorded reading was taken of the elongation occurring in the course of the test. For this purpose the machines were equipped with the apparatus shown in Fig. 2. A small incandescent filament lamp, with the aid of the diaphragm *k* (which has an opening of 0.3 mm. diameter) and the condensing lens, projects a fine beam of light. This beam is incident upon the 2 staggered mirrors, and produces a lightspot of about 0.75 mm. diameter upon the light-sensitive paper wrapped around the drum *O*. The diaphragm *P* serves to regulate the luminosity of the light spot. The drum, driven by clock-work, makes one revolution every 48 hours, so that with a 48 cm. record a time scale of 1 cm. = 1 hr. results. The light projecting apparatus as well as the measuring drum are secured to the base of the machine. The arrangement of the mirrors represented in Fig. 2 serves to record the elongation directly, in the scale of 1:1000.

The continuous recording of the elongation phenomena affords considerable advantages over obtaining the elongation-time curves by readings taken at stated time intervals. Upon taking readings with the telescope, fluctuations of the scale are frequently observed which prevent accurate measurement and permit only approximate evaluation of the scale reading. Since the period of these oscillations is so short that no noticeable blackening of the silver-bromide paper results, they are automatically eliminated by the light-recording arrangement and re-

[1] A. Pomp & A. Dahmen. Entwicklung eines abgekürzten Prufverfahrens zur Ermittlung der Dauerstandfestigkeit von Stahl bei erhöhten Temperaturen. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung*, Vol. 74, 1927, pages 33-52.

*Kaiser Wilhelm Institut für Eisenforschung, Düsseldorf, Germany.

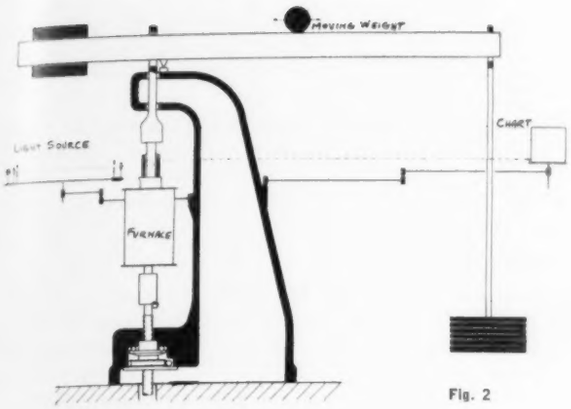


Fig. 2

main without effect on the measurement indication. Carrying out of the tests is further appreciably simplified by their proceeding automatically throughout, since there is the added possibility of keeping track of the elongation phenomena during the night without imposition on the attendant operators.

Figs. 4-12 show, on a reduced scale, some of the elongation time records. For very prolonged elongation recording, the accuracy of the rate of elongation measurement can be taken as $\pm$ 0.00005%/hr. assuming a measuring interval of 10 hrs. The most important advantage of the automatic elongation recording lies in the avoidance of errors which, when individual readings are taken at definite time intervals, may occur just at the moment of the reading, when, for an instant, due to a slight change in temperature, a transitory elongation may take place which does not represent the true course of plastic elongation. The elongation time characteristic of Fig. 11 serves as an example of this. From that curve the error in elongation indication due to a transitory temperature disturbance can be distinctly recognized.

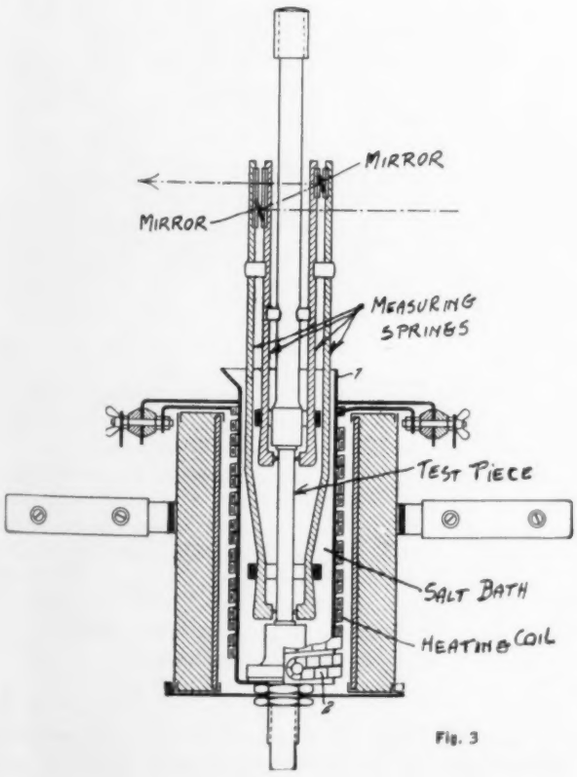


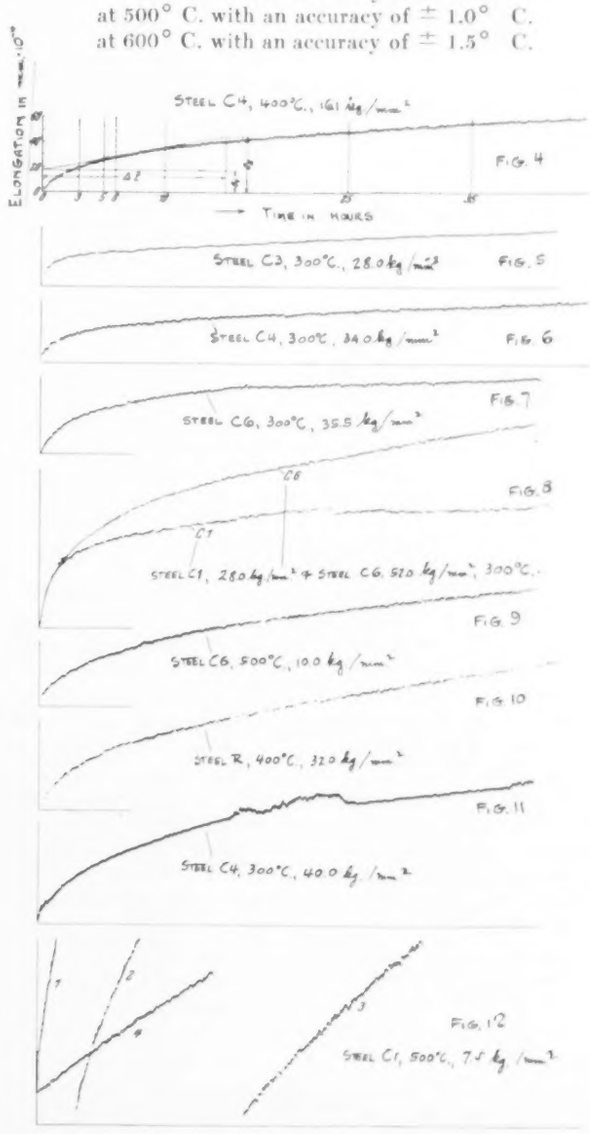
Fig. 3

Particular value was attributed to keeping the testing temperature dependably constant, for even slight temperature changes exerted a great influence upon the rate of elongation. In the following investigation the necessary constancy of temperature was attained through regulation of the heating current and through special provision for maintaining a uniform room temperature. Since the voltage fluctuations of the line were as high as $\pm$ 15%, an oil pressure type high-speed voltage regulator controlling to an accuracy of $\pm$ 0.5%, was built into the apparatus for the regulation of the heating current.

Bother in holding the room temperature constant was avoided by setting up the entire assembly of testing apparatus in an underground room. This location at the same time afforded the advantage of great freedom from vibration. Even with the more severe temperature changes of the outdoor atmosphere during the colder part of the year, the fluctuations of room temperature could, with the aid of a ventilator which was coördinated with a temperature regulator, be kept down to a range of 3° C.

With the aid of these measures it was possible, over a test period of 48 hours, to keep the temperature of the salt baths constant.

at 300° C. with an accuracy of $\pm$ 0.25° C.
at 400° C. with an accuracy of $\pm$ 0.5° C.
at 500° C. with an accuracy of $\pm$ 1.0° C.
at 600° C. with an accuracy of $\pm$ 1.5° C.



The temperature measurement was carried out with the aid of a resistance type thermometer with an accuracy in reading of $\pm$ 0.25° in a scale division of 2°.

Obtaining the Elongation-Time Curves

In order to reach a decision on the possibility of determining the creep strength through a suitable method of test acceleration, precision measurements of elongation were carried out with the apparatus described. Test rods of 10 mm. diameter and 100 mm. length were used. Each test rod was utilized only for a load at one temperature—that is, for one single test. The carrying out of these tests took place in the following manner: The test bar, together with the previously heated oven, was clamped into the loading machine and loaded with a light preliminary load (about 40 kg.). Then followed the setting up of the light pointer and the adjustment of the test temperature. When these preparations had been made, an interval of at least 4 hours was allowed to elapse for the necessary temperature equalization throughout the entire test assembly before applying the load. The normal duration of the loading was 42 hours. The total duration of the test, including the time necessary for clamping the test bar and for temperature equalization, was 48 hours, so that every second day a new test could be started. Certain test bars were subjected to a longer test period which ran to 2400 hours, in order to determine the course of the elongation over a longer space of time.

In Figs. 4 to 12 are reproduced on a smaller scale certain of the elongation-time curves produced by means of a light beam on the automatic recorder, which represent the original curves taken with elongation recorded as ordinate in the ratio of 1:1000 and the time as abscissa on the scale of 1 cm. = 1 hour. They show, after a steep initial rise, one region of rapid and one of gradual bending towards the time axis. In every case momentary small, irregular, fluctuations which can be traced back to slight temperature variations, are to be seen all through the curves.

Fig. 12 shows a repeatedly interrupted stretch of the curve. This is due to the fact that the point of light was brought back to the starting point at the lower edge of the chart paper by turning back the mirror to the starting position as soon as the light beam overtraveled the dimension of the chart strip, due to too great an elongation.

Evaluation of the Elongation-Time Curves

For studying the elongation procedure the increase of elongation was determined from the curves for each time interval from the 3rd to 6th, 5th to 10th, and 25th to 35th hours after applying the load. The time interval of the 3rd to the 6th hour was chosen to check up on the practicability of the method for determining creep limit suggested by A. Pomp and A. Dahmen. The measurement of elongation velocity in the time intervals of 5 to 10 and of 25 to 35 hours was intended to disclose; first, to what extent elongation decreases with time; and secondly, what advantages are afforded by measurement of elongation at a later time interval than between the 3rd and 6th hours. Fig. 4 illustrates the method of evaluation.[2] The perpendiculars erected on the time axis at the points corresponding to 3, 5, 6, 10, 25, and 35 hours are extended to intersect with the smoothing out curve which is drawn through either the upper or lower edge of the observed curve. The slope of the line connecting the points of intersection gives, for the time interval chosen, a measure of the average rate of elongation v, from the equation.

$$v = \frac{e_2 - e_1}{\Delta t}$$

where e_1 and e_2 signify the ordinates marking the beginning and the end of the time interval Δt. By way of example the method of evaluation is graphically illustrated in Fig. 4 for the time interval from the 5th to 10th hour.

[2] A. Pomp & Walter Enders, Zur Bestimmung den Dauerstandsfestigkeit in Abkürzungsverfahren. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung*, Vol. XII, Report 152, 1930, pages 127-148.

Conclusion

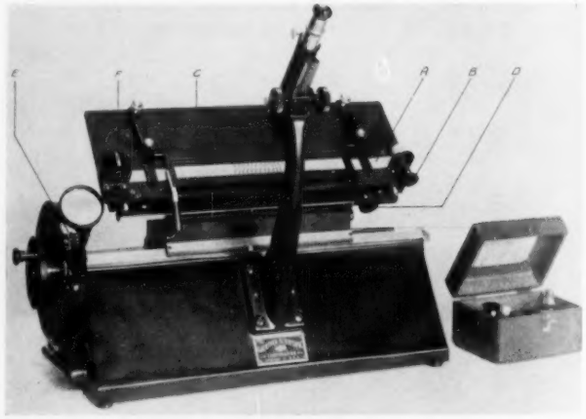
On the basis of tests which were prolonged to a duration of 2400 hours it was determined that, in the 3rd to 6th hour, higher values of rates of elongation than 0.001% per hour can be allowed. Alternatively to the proposal made by Pomp and Dahmen, the creep limit for carbon steel is proposed as that maximum load for which, in the time interval between the 5th to 10th hour, an elongation rate of 0.003% per hour is not exceeded.

◈ ◈ ◈

Novel Method of Production Timing

(Continued from Page 165)

both illuminated by a 6-8 volt incandescent lamp. Upon completion of measurement of the first row of punchings, the upper stage is then shifted to the next row of holes. This is accomplished with two racks attached to the carriage in which engage two pinions mounted on a common shaft, rotated by worm and worm wheel, manipulated by head "D." The second row is measured in like manner, etc., the measured portion being wound by head "B." In this manner a full length of the day's production, which represents approximately 10 ft. of tape, is measured, giving the time of the completed operations throughout the day accurately to fractions of seconds.



Comparator

From these tests have come some startling results, startling because they were unexpected as well as because they were sometimes contrary to accepted opinion.

In the first place there was a gradual yet steady increase in production regardless, to a certain extent, of test conditions imposed. For some operators this increase has run as high as 35% to 50%. And the study has continued too long to attribute this increased production to the novelty of being placed under observation. The highest productivity yet reached was recorded in the period during which the operators had a fifteen minute rest and lunch period in the morning and a ten minute rest period in the afternoon. The lowest period of productivity was the first one in the test room with no change from regular working conditions.

The ENGINE INDICATOR

Its Design and Theory

By KALMAN J. De JUHASZ *

(Continued from June Issue)

The foregoing examples show numerous modifications of the component parts. These are discussed in detail below:

1. **The frame or body** serves to locate the parts of the indicator in their required position relative to one another. It therefore must be sufficiently strong and rigid to withstand the forces exerted upon it without failure or flexure. On the Crosby indicator shown in Fig. 6 the frame consists of an upper and a lower part, screwed into one another, with the flange of the indicator cylinder nipped between them. The drum axle is fixed into the extension of the upper part. It is important that the drum axle be truly parallel to the cylinder axis, respectively to the path of the pencil point, otherwise error is liable to result. If the path of the pencil point intersects the drum axis (i.e., is coplanar with it), the pencil pressure will be different in the upper and lower portion of the ordinate and an error due to friction will result. If the path of the pencil point does not intersect the drum axis (non coplanar with it) than in addition to the above difficulty the ordinate will be oblique to the abscissa line.

In some recent types of indicators the upper and lower parts of the frame form one integral piece and the cylinder proper is screwed in from above. This arrangement has the advantage of the cylinders being removable, without disturbing the rest of the apparatus. To the lower part is attached the union nut which connects the indicator body with the cock, or valve, by means of a male-female cone; (bevel taper is normally 1:10).

The material of the frame is usually tough grained bronze casting.

2. **The indicating valve** connects the indicator proper to the engine cylinder. It is usually made of bronze, for ammonia compressor service it is made of steel or cast iron. For not too high pressures and temperatures it is usually made in the form of a cock valve, while for high pressures and temperatures the cone type is preferable. In either form it must have 3 openings, namely: one to the engine, one to the indicator cylinder, and a small opening to the atmosphere. This latter opening has a two-fold purpose, i.e. for drawing the atmospheric line for reference, and, on steam engines, to free the passage from condensed water which might cause undesirable hammer effect and inertia errors in the indicator. The respective positions of the handle must be clearly marked.

Some indicator valves are provided with water cooling (Fig. 20c). This has the disadvantage, however, that should the water cooling fail, binding is sure to follow. Conical valves are shown in Figs. 21 a-d, and some adapters in Fig. 22a-c.

In slow moving engines it is permissible to use one indicator for indicating both ends of the cylinder. In such cases an elbow cock (Fig. 20d) is placed in the middle of a pipe line connecting the openings on both ends of the cylinder. This pipe should have a generous cross section, about ½ in. diameter, in order to avoid throttling. It is good practice to cover this pipe with asbestos tape or other heat insulating material.

At high speeds the error introduced by a long pipe may cause considerable error owing to wire drawing. In such cases, the connection has to be as short as possible, and at least as wide as the opening into the indicator cylinder.

3. **The cylinder and piston.** In most modern constructions these are easily removable from the frame and from the piston rod respectively and can be interchanged with sets having different cross sectional areas (See Figs. 6-19). The *normal size* piston usually has one-half square

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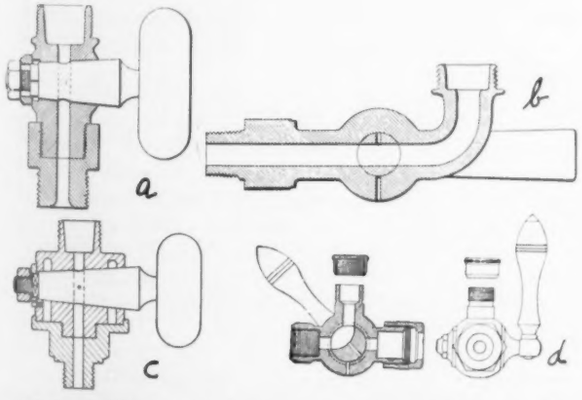


Fig. 20. Cock Valves. a) Normal Plug Cock (Maihak); b) Elbow Cock (Maihak); c) Water Cooled Cock for Internal Combustion Engines (Lehmann and Michels); d) Elbow Cock (Crosby) for indicating the two sides of a steam engine with one indicator.

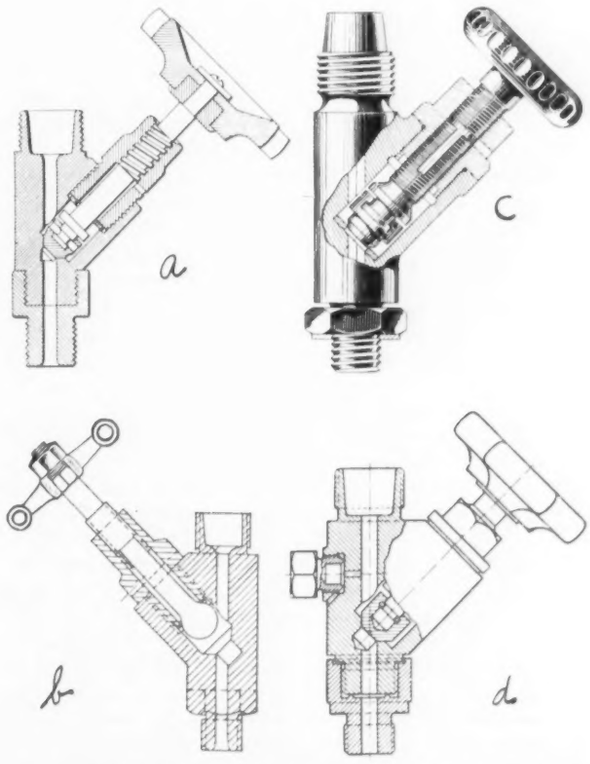


Fig. 21. Conical Valves. a) Maihak: Valve is free to rotate on stem. b) Lehmann and Michels: Note ball shaped end. c) Dobbie McInnes: Note separate seat washer, and method of connection with atmosphere. d) Schaeffer and Budenberg: Note separate valve for connection with atmosphere.

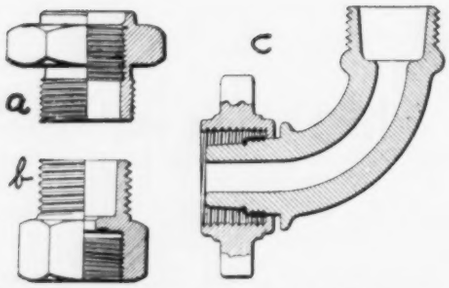


Fig. 22. a) and b) are Adapters for Valve and Indicator Respectively; c) is an Elbow Coupling (Maihak)

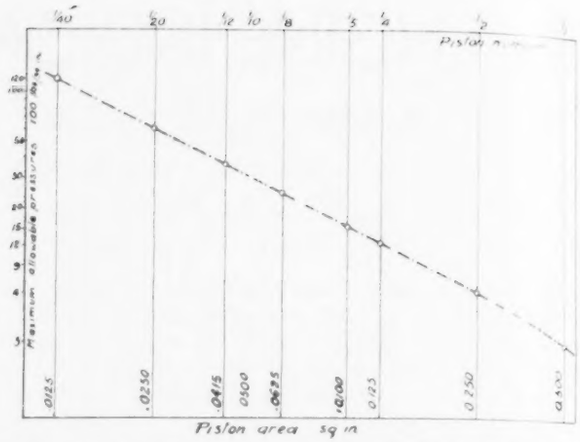


Fig. 23. Chart Showing Sizes of Pistons Recommended for the Different Maximum Pressures

inch area, (20.27 mm. dia.) and smaller ones have areas ½, (¼), 1/5, (1/6), (⅛), (1/10), (1/12), (1/20) and (1/40) times that of the normal size. Some European makers adopted the 20 mm. diameter as standard, which leads to an undesirable variation in springs. For indicating slight pressure variations, such as occur in blowers and in intake and exhaust manifolds of internal combustion engines, a piston with twice or even four times the normal area is used. Such is shown in Fig. 16. The small cylinders are sometimes formed in the connecting cone itself in order to keep at low value the volume added to the compression space of the engine or compressor. A further advantage of this construction is that large bursting forces are avoided which would occur if the pressures were acting on the large surfaces inside the indicator cylinder.

The normal size cylinder is usually fixed in the frame at one end only, leaving an annular steam jacket. This method equalizes the pressure and temperature on both sides of the cylinder wall and thus prevents distortion of this important component. For internal combustion engine service, however, it is better to close up the jacket at the lower end of the cylinder also, thereby lessening the overheating of the cylinder. In the case of the smaller cylinders, which are used for high pressures, this method of construction has the merit of preventing the high pressures from acting on large surfaces and consequently avoiding stressing of the indicator walls. On the other hand, with this type of construction, sufficient cylinder wall thickness can (and in fact must), be provided in order to avoid stressing the material beyond its elastic limit; but the above construction allows for providing this extra wall thickness without difficulty. The reduced annular space is frequently utilized for the storage of lubricant.

Usually the cylinder is made of tough bronze. For ammonia compressor service it is made of cast iron which is not corroded by ammonia. An indicator with iron liner is shown in Fig. 16e.

The piston is made of hardened tool steel, lapped to a close, yet free fit in its cylinder. It is hollowed out in order to reduce its mass and the inertia errors. Usually shallow circumferential grooves are formed on its surface in order to reduce leakage (the effectiveness of which grooves is questionable) and to provide a receptacle for the lubricant and eventual grit and other impurities. In some indicator types this objective has been carried so far as to build the piston out of a number of thin discs with a gap between each (Figs. 11, 12, 13). It is claimed that this construction ensures a more even expansion and less distortion under high temperature conditions, than is the case with the usual design. On the other hand it results in a heavier piston.

In order to avoid bending strains and wedging of the piston, which might be caused by an eccentrically applied spring force, pistons of external spring indicators are in some cases made spherical instead of cylindrical. Such a design is shown on Fig. 6. While effectively avoiding bending, this construction has, however, the disadvantage of more rapid wear owing to the small area of contact and to the wedging action of eventual dirt or grit. The wear is objectionable not so much on account of the change of piston area, which is negligible, but owing to the inconvenience and eroding action of the steam or hot burnt gases blowing through the gap between the cylinder and the piston.

For steam engine service it is usually sufficient to dip the indicator piston into lubricating oil occasionally. For internal combustion engine service, where the medium has no lubricating properties, a more positive and continuous lubrication is needed. This is usually provided by means of a screw fed grease cup, communicating with the cylinder jacket space of the indicator, whence the lubricant passes through small holes to the surface of the piston. It is important in such construction that the holes be covered by the piston at all times, i.e. in both extreme positions, otherwise a blow-through takes place (Fig. 16g).

Interchanging the cylinder and piston sets on the one hand and the springs on the other hand, gives a wide choice of pressure scales. As a general rule, using a large piston is preferable, because then the influences of friction and of the recording gear inertia are in smaller ratio to the fluid forces.

The piston is fastened to the piston rod by screwing the latter into the piston directly, or, by means of a sliding fit onto the rod and a special retaining screw. The latter method provides better centering and is therefore preferable.

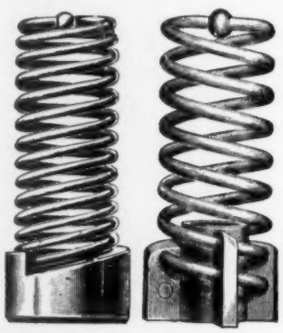
4. The piston rod connects the piston to the spring and to the recording gear. It must be strong enough to withstand the forces involved without bending. It is preferably made tubular to reduce its mass. In outside spring indicators the piston rod has considerable length and in some designs (Figs. 6, 12, 13) it is forked in order to allow the motion of the pencil arm. In inside spring indicators the spring force acts directly on the piston and therefore the piston rod is stressed only by the accelerating forces of the recording gear.

The piston rod should not be loaded with forces greater than about 150 lbs. corresponding to 300 lbs./in.^{2} pressure on the normal size piston. In indicating higher pressures, proportionately smaller pistons have to be used, according to the following table:

Piston size, No.	4/1	2/1	1/1	1/2	(1/4)	1/8	(1/16)	1/10	(1/12)	1/20	1/40
Piston area, in.²	2	1	0.5	0.25	0.125	0.100	0.0625	0.05	0.0415	0.0250	0.0125
Max. allowable press. lbs./in.²	75	150	300	600	1200	1500	2400	3000	3600	6000	12000

Usually the piston rod is provided with a thicker collar which butts against a stationary stop on the indicator cover plate in order to limit the movement and thereby to prevent an excessive strain on the spring.

5. The Spring. Ever since the earliest indicators the helical type of spring has been used for measuring the piston force. A number of other spring types, such as bar, or cantilever type, bow spring and the Bourdon type of tube—which latter combines the function of cylinder, piston and spring—have been proposed but were abandoned, save in some rare cases of special indicator applications. The advantage of the helical spring is based upon its favorable energy to mass ratio. In earlier types of indicators the single coil spring was used (Figs. 8, 9, 10), which was superseded by the double coil spring (Figs. 11, 12) owing to its more accurately concentric load. This is composed of two coaxial single coil springs. The two ends of the spring are fastened into heads, which in turn are secured to the piston or piston rod and into the indicator frame, respectively. In the latter part of the nineteenth century G. H. Crosby invented a double coil helical spring wound of a single wire, in which a small steel bead soldered onto the middle of the wire, takes the place of the movable head, Fig. 24. This type of spring has the merit of easy manufacture, smaller moving mass, and concentric load—for which reason this type of spring is nowadays being used very extensively. (Figs. 6, 7, 14, 15, 16.)



a b

Fig. 24. Double Coil Indicator Springs. a) Lehmann and Michels Tension Spring. Note coils wound closely with space between them sufficient for contraction under vacuum. b) Crosby Compression Spring With Wide Gap Between the Coils.

The spring is used either in tension or in compression. The tension-springs are closely wound, with just so much gap between the coils as is necessary to prevent their coming into contact when the indicator piston is subjected to vacuum. (Fig. 24a) The compression springs (Fig. 24b), on the other hand, must be so widely wound, that the gap between the coils closes only at the highest pressure for which the spring is designed. In the outside spring type of indicators usually (but not exclusively) the tension type of spring is used, while in the inside spring type the compression type of spring is exclusively employed. The compression spring is more liable to bending under load than the tension-spring. On the other hand the latter type requires a longer piston rod.

On the foot of the spring is stamped the scale of the spring: i.e., that pressure in lbs./in.² which, acting on a normal size piston, produces one inch displacement of the recording pencil.

For example, with a spring marked 40, one inch displacement of the recording pencil corresponds to 40 lbs./in.² pressure, when a normal size piston (½ in.²) is used. The same spring used with a ½ size (¼ in² area) piston would give a scale of 80 lbs./in.² to one inch of piston displacement. The spring scales with various combinations of spring and piston areas are tabulated in the following table:

Pressures required to give 1 in. pencil displacement when used with pistons of various areas

Spring No.	Piston Area in.² 1/2	1/4	1/5	1/10	1/20	1/40	1/80
4	4	8	10	20	40	80	160
8	8	16	20	40	80	160	320
12	12	24	30	60	120	240	480
16	16	32	40	80	160	320	640
20	20	40	50	100	200	400	800
30	30	60	75	150	300	600	1200
40	40	80	100	200	400	800	1600
50	50	100	125	250	500	1000	2000
60	60	120	150	300	600	1200	2400
80	80	160	200	400	800	1600	3200
100	100	200	250	500	1000	2000	4000
120	120	240	300	600	1200	2400	4800
150	150	300	375	750	1500	3000	6000
180	180	360	450	900	1800	3600	7200

In countries using the metric system the spring scale is given in millimeter pencil displacement corresponding to 1 kg./cm.² pressure difference. The conversion of the American spring scale into metric can be effected by the following formula:

X lbs./in.² for one inch of pencil travel corresponds to:

$$\frac{360}{X} \text{ mm. travel for each kg./cm.}^2$$

Table of Indicator Springs Scales in metric units.

Pencil Travel in mm. Corresponding to 1 kg./cm.² pressure change.

Spring Scale	Piston No. 4/1	2/1	1/2	1/5	1/10	1/20	1/50
	Area (in.²) 2	0.5	0.25	0.1	0.05	0.025	0.01
	Dia. (mm.) 40.51	20.27	14.35	9.06	6.41	4.53	2.866
60	240						
45	180	45					
30	120	30					
25	100	25					
20	80	20					
16	64	16					
12	48	12					
10	40	10					
8	32	8					
6	24	6					
5	20	5	2.5	1	0.5	0.25	0.10
4	16	4	2	0.8	0.4	0.20	0.08
3.5		3.5					
3		3	1.5	0.6	0.3	0.15	0.06
2.5		2.5	1.25	0.5	0.25	0.125	0.05
2		2	1	0.4	0.2	0.10	0.04

Note: This table shows only the usual combinations of springs with pistons according to the recommendation of European indicator manufacturers.

An ideal indicator spring would be one with a constant scale over its whole range, i.e. equal differences in pressure should produce equal differences in displacements. Also, changing of temperature should have no effect on the scale. Actually this is not the case; variations in the spring scale depending on the displacement, and also on temperature, are an inherent characteristic of the spring as the following brief theory shows:

The force P corresponding to a given change of length f of a cylindrical helical spring can be expressed as:

$$P = \frac{d^4 G}{64\, nr^3} f = cf$$

where d = diameter of wire
G = torsional modulus of elasticity
n = number of coils
r = mean radius of coil

$$I_p = \frac{\pi d^4}{32} = \text{polar moment of inertia}$$

$2r\pi n = l$ = length of wire

$$c = \frac{d^4 G}{64\, nr^3} = \frac{I_p G}{lr^2} = \text{spring constant}$$

When a spring is compressed, the mean radius of the coils increases, consequently the spring constant decreases. In a similar manner the spring constant increases when a spring is extended. Besides the torsion, the spring coils are also subjected to bending stresses which

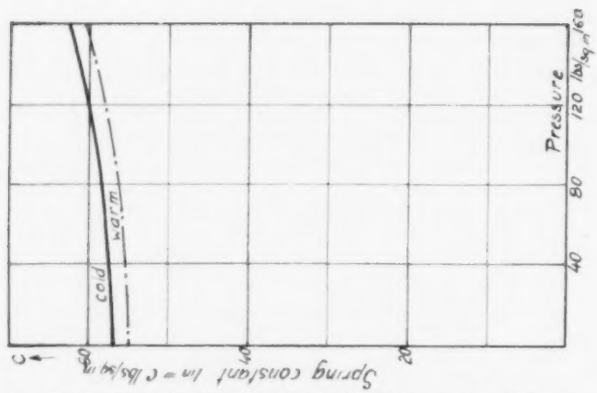


Fig. 25. Chart Showing Change of Spring Scale With Temperature and Pressure. Spring Constant Increases With Increasing Pressure and With Decreasing Temperature

the above simple formula does not take into account and which also contribute to the variation of spring constant. This undesirable variation in the spring constant can be lessened by using a large number of coils. However, doing this involves a heavier spring for a given spring constant. Therefore a certain compromise is unavoidable.

With a rise in temperature the modulus of elasticity (G) decreases. The above formula shows that this produces a lowering of the spring constant. For this reason in heat engine service an outside spring indicator is to be preferred, while on pumps, where the spring is not exposed to high temperatures, the inside spring type of indicator gives more accurate results owing to the smaller moving mass involved.

The influence of the displacement and of the temperature on the spring constant is shown on the chart of Fig. 25.

In a few types of indicator (notably in the Maihak cantilever type of indicator, to be described later) a beam spring, subjected to bending, is employed. In this case also the force is proportional to the deflection, so for example in the case of a triangular plate spring, (form of uniform strength) fixed at one end and loaded at the apex by a concentrated force, it can be expressed:

$$P = \frac{2EI}{l^3} f = c\,f$$

where l = length of spring;
E = longitudinal modulus of elasticity;
I = moment of inertia at the fixed end section;

$$c = \frac{2EI}{l^3} = \text{spring constant.}$$

For other shapes, such as a rectangular beam of uniform cross section, or for a tapered beam, the spring constant can be expressed by similarly constructed formulas. (See: Marks' Mechanical Engineers Handbook.)

Among the springs having the same spring constant c and the same allowable deflection f, the one having a shorter natural period of vibration is superior for indicator service—other things being equal. This criterion is equivalent to:

1) having a smaller active mass (or volume, if the same material is used);
2) having a smaller deflection of its center of gravity.

The amount of energy stored up in the fibre stress of the spring is the same for both springs, but the volume of active spring material needed for the storage of this energy will not be, generally speaking, the same, if both are to have the same factor of safety. The energy stored up (called "resiliency") of a helical spring of circular cross section is:

$$U_1 = \frac{1}{4}\,\frac{S_v^2}{G}\,V$$

and that of a triangular cantilever plate spring is:

$$U_2 = \frac{1}{6}\,\frac{S_s^2}{E}\,V$$

where V = volume of the spring;
S_v = torsional stress, and
S_s = stress in tension or compression.

For spring steel the following values hold good:
$E = 30{,}000{,}000$ lbs./in.^{2};
$G = 12{,}000{,}000$ lbs./in.^{2};
$S_s = 40{,}000$ lbs./in.^{2};
$S_v = 28{,}000$ lbs./in.^{2}

With these values, (which may vary greatly with different materials) the following values are obtained for the resiliency:

$U_1 = 16$ in.-lbs.; $U_2 = 9$ in.-lbs.

This shows a marked superiority in favor of the helical spring. The beam spring has, however, a smaller deflection of its center of gravity (or rather of its center of oscillation) for a given deflection of its free end, than has the helical spring. Furthermore, the use of a helical spring involves a longer piston rod with its greater inert mass. These circumstances may compensate the disadvantage of the beam spring, as the success of the Maihak beam spring indicator shows.

For normal indicators, however, the helical spring is generally used owing to its ease of manufacture and application, its more compact form, and above all, owing to its truly concentric loading on the piston.

(Continued in the August 1932 issue)

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The Iron & Steel Exhibit

OF THE Iron & Steel Electrical Engineers Convention at Pittsburgh on June 21-23, was of great significance to the entire field of measurement and control. For one impression gained at the exhibit was that the steel industry is becoming control conscious. Fuel-air controls for open hearth furnaces were prominent for the attention they attracted, likewise, the automatic combustible-gas analyzers for controlling of furnace and annealing atmosphere—and of course electrical controls for crane, rolling mill, and other drives were there in abundance.

Another impression formed at this exhibit was that the instrument industry is becoming aware of the many application possibilities, in diverse fields, for devices developed for one special field. The fuel-air ratio control has branched out of its original field, steam generation, into the control of open hearth combustion. Automatic gas analyzing apparatus has expanded from the field of flue-gas analysis to controlling the atmospheres of heat treating and annealing furnaces.

Altogether the exhibit indicates that the steel and instrument industries are drawing increasingly closer together, to the greater advantage of both.

◆ ◆ ◆

M. Herbert Eisenhart, vice-president and general manager of the Bausch & Lomb Optical Company of Rochester has just been elected to a 5 year term on the board of the Massachusetts Institute of Technology.

◆ ◆ ◆

Dr. G. K. Burgess, Director of the Bureau of Standards, died of cerebral hemorrhage on July 2.

Flow Measurement and Control*

By M. F. BEHAR**

CHAPTER XXV HEAD METERS

(Continued)

§ 13 to § 16—INSTRUMENTS

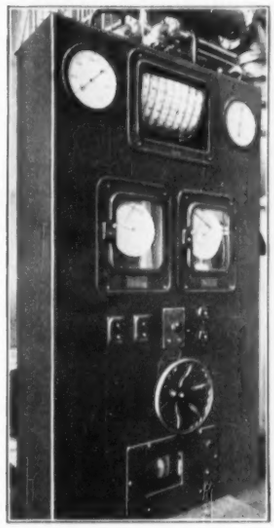
The remaining sections of this chapter deal with various secondary and other devices which, together with the various primary elements described in § 7 to § 12, go to make head meters. Such instruments are divided as usual into indicating, recording, integrating, controlling, and combinations such as recorder-controllers, etc. For controlling instruments refer to Chap. XXVII on automatic control of fluid flow, where controllers of the "head" class naturally predominate. This leaves the indicating, recording and integrating instruments—that is to say the devices which are frequently referred to as "flow meters" because they embody scales, graphic elements and counters, the functions of which always have to do with measuring or metering, no matter what apparatus they are associated with. These instruments, however, considered apart from primary elements, are not head meters, are not flow meters. Most of them are essentially *differential pressure indicators and recorders,* can be used independently as such, lend themselves to study as such and will be dealt with as such. Some of the more elaborate instruments discussed below, however, are intimately associated with primary head metering elements and will be discussed as head meters—a necessary procedure in the case of head meters consisting of instruments associated with automatic or compensating primary elements that do not produce differential heads varying as the square of the rate of flow. But *all indicators* discussed below are in fact differential pressure gages and will of course be discussed as such.

A discussion of instruments logically starts with a classification. The instruments for indicating the usual differentials in head metering practice—say between a fraction of an inch of water and 15 inches of mercury—can be divided into a considerable number of mutually exclusive classes, the characteristics of all of which are discussed in Part Four (Pressure Measurement and Control). Moreover, such is the variety of these instruments that not one but a number of schemes of classification have been proposed, and Chapters XVI and XVII contain several tables, some made up and contributed by authorities more prominent in fluid meter technology than in pressure measurement. It also goes without saying that practically all of the gages (suitable for differentials between 1 in. H_2O and 15 in. Hg) dealt with in Part Four can be used as secondary elements of head meters, and that many are chiefly used for this purpose. But now that the self-same instruments are to be considered as the value-assigning elements of head meters, the author finds himself bound to recognize certain engineering aspects (of this whole question of nomenclature and classifications) which compel an entirely different method of approach.

In short, we have to go right back to fundamental distinctions. It is true that this whole Manual deals with *industrial* measurements as distinguished from scientific laboratory measurements. It is equally true that we have made plain the most important division of all measuring functions *within* the field of Instrumentation—for which division we need not refer the user of this Part to our previous discussions, for he will immediately appreciate it when comparing the use of a dead-weight gage tester with the continuous service of a Bourdon gage. Nor have we neglected to define the qualifications of Plant Standards such as gage testers. But it seems that this is not enough. In the province of fluid measurements, and especially in that of rate measurements, a controversy rages between some eminent authorities who condemn all "commercial" head meters as inacceptable for test work and others who maintain that some of their "commercial" head meters are sufficiently sensi-

*Part Six of *The Manual of Instrumentation.*
**Engineering Editor.

FOR BOILER CONTROL



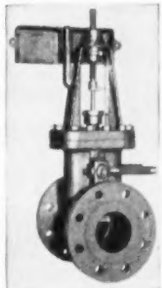
THE BAILEY BOILER PANEL gives complete information for controlling boiler operation. It contains the Bailey Boiler Meter, a Bailey Fluid Meter with which is combined a Boiler Water Level Recorder, and a Bailey Multi-Pointer Gage. The operator has everything right before him to obtain the desired capacity and best efficiency at all times. Request recommendations for your boilers.

PRESSURE GAGE

Extremely accurate gages embodying the dead weight gage tester principle are available in several sizes up to 36" in diameter for indicating at remote points the pressure of steam, water, gas, etc. These gages can be used with any pressures and are particularly suitable for magnified ranges. Ask for Bulletin No. 70.

LONG DISTANCE INDICATOR

Bailey Meter Selsyn Operated Equipment for recording and indicating pressure, temperature, draft, liquid level, etc. at any distance from the source is highly accurate and reliable. Described in Bulletin No. 110.



ADJUSTABLE ORIFICE

The Bailey Adjustable Orifice is for use with Fluid Meter installations where accurate measurements are desired over a flow range of as wide as 160 to 1. Ask for details.

BAILEY METER CO.
1041 IVANHOE ROAD
CLEVELAND, OHIO

INSTRUMENTS EMPLOYMENT SERVICE

No charge for insertion of notices, which should be addressed to INSTRUMENTS Employment Service, 3619 Forbes Street, Pittsburgh, Pa., should be written tersely and must be received by the 25th of the month. In replying, put identification number on both envelope and letter.

MEN AVAILABLE

INSTRUMENT MAKER: 3½ years experimental laboratory of lamp company; 2 years experimental laboratory of electrical company. J-2.

PYROMETER MAN: Graduate Pennsylvania State College. Had charge of pyrometer calibration laboratory in plant with 1100 pyrometers. J-3.

ELECTRICAL ENGINEER: Graduate Charlottenburg Technische Hochschule; 8 years research engineer with chemical company; 4 years steel plant electrical engineer; can read German, French, Spanish and Italian. J-6.

INSTRUMENT SALESMAN: Mechanican Engineering Graduate; experienced sales and service most type of power plant instruments. District Sales Manager 5 years. Experience on gages, flow meter, CO_2 recorders, pyrometers and other testing equipment. J-8.

PYROMETER MAN: 8 years experience; expert electrician and gage (hydraulic, pressure, vacuum, etc.) service man; 3 years instrument laboratory; education equivalent two years of engineering college. J-9.

INSTRUMENT ENGINEER: Graduate Engineering College. Charge of instrument department in large industrial plant for 2½ years. J-10.

RADIO OPERATOR: Graduate Dodge Institute, 1917. Commercial license either broadcast or telegraph. J-12.

INSTRUMENT SALESMAN: Graduate M.E., 4 years control instruments, 2 years power plant specialties, 4 years manufacturing experience, in shop. Now N. Y. District Mgr. large rolling mill. J-13.

PHYSICIST: Ph.D. 1927. Experienced in electric and magnetic measurements, testing and research. J-14.

PRECISION INSTRUMENT MAKER: 28 years experience on scientific and geophysical instruments. J-15.

RADIO ENGINEER: Graduate University of Illinois; 2½ years experience in radio set circuit and tube measurements as well as development, design and patent investigation work. J-16.

ELECTRICAL METER and INSTRUMENT MAN: Technical graduate, 8 years in instrument laboratory of electrical manufacturing company. J-17.

INSTRUMENT ENGINEER: 2 years university, 5 years public utility, 2 years sales and service large recording and controlling instrument manufacturer. J-18.

INSTRUMENT MAKER: Engineering and Drafting instruments, 20 years shop experience, Master Degree Guild of Nuremburg. J-19.

ELECTRICAL ENGINEER: Graduate Purdue University. Experience with Telephone and Telegraph circuits, industrial control methods and equipment, and electrical instrument testing and maintenance. J-20.

AIRCRAFT INSTRUMENT MAINTENANCE ENGINEER: Formerly Service Engineer for largest manufacturer of aircraft instruments. Especially familiar with airplane instrument problems. J-21.

tive and accurate for exacting test work involving the acceptance or rejection or rating of plant units costing tens of thousands of dollars.

After several years of correspondence and consultations with members of both groups, and after receiving valuable assistance from several on each side, the author finds that the only policy satisfactory to both would be for him to declare that head metering applications in test work do not pertain to Instrumentation. This facile policy would merely be dodging the issue and here is why: In most of the divisions of measurement corresponding to other divisions of this Manual there are obvious differences between laboratory tests and plant service—differences of methods, of apparatus or of the men who use the instruments and apparatus. But when it comes to measuring quantity rate, the methods and apparatus for important tests differ but little from those for indicating rate of flow in process work where accuracy is desired; and what is especially significant, the qualifications of test engineers and of process engineers responsible for accurate flow determinations by means of indicating head meters would seem to coincide in almost every respect. Lest these assertions be misconstrued, we wish to emphasize their application to determinations, that is to say, to the use of indicating instruments: our point is that the devices selected for test work as above described are of necessity "commercial" devices, and therefore that to endorse the recommendations which well-meaning and distinguished engineers have been earnestly endeavoring to write into official codes, with respect to the condemnation of all commercial flow meters, would preclude the use of some if not most of the very instruments which these authorities themselves rely upon when engaged in testing the performance of the largest and costliest units.

This has nothing to do with instruments that are not only "commercial" but designed for ruggedness, convenience and readability, at the expense of scientific precision, so that they are obviously disqualified for adoption as Standards.

Nor are we considering recorders and integrators designed for permanent installation. These, as well as the dial indicators, are calibrated by comparison.

Here, then, is a reasonable criterion whereby to classify indicating instruments of head meters with reference to suitability for exacting test work: whether the instrument, *in principle*, is a "primary" head-metering instrument, i.e., one that can be constructed and calibrated without reference to another head-metering instrument.

In principle, liquid-in-glass manometers are primary instruments, while indicators with mechanical movements and pointer-and-scale arrangements are not. In practice, one may find that a particular glass manometer, say a small and crude U-gage, may not qualify, while a carefully designed float-actuated pointer type of dial indicator may qualify as a "primary instrument." Therefore a definite classification into "glass" and "dial" indicating manometers carries no invidious distinction, and it is adopted.

13. Glass Indicating Manometers

(a) General Notes

Two principal forms are the U-tube with equal diameter legs, and the single-column manometer, also known as the "cistern" or "barometer" type. (Manometers of which the reservoirs are of other materials than glass are included under this heading if the reading tube is of glass.) For low differential heads there are inclined-tube manometers and various forms of micromanometers.

Standard manometers, for test work and for calibrating dial-indicating, recording, and integrating instruments, are chiefly made up in the U-tube and single-column forms.

Purely industrial manometers, to be installed permanently on power plant or process fluid metering applications, are made up in practically all forms except those of micromanometers, most of which are portable instruments.

In manometers for gases, a light oil is found preferable to water as the manometric liquid, since the water meniscus tends to stick to the glass unless the latter is nearly perfectly clean, whereas the oil meniscus operates frictionlessly. Butyl phthalate may be used to "lubricate" the meniscus in a mercury manometer.

For measurement of oil flow it may be necessary to use water seals to keep the opaque substance out of the glass tubing. Most oils also emulsify mercury so that it forms a "mud." Dirty mercury can be purified by the repeated use of unusually good oil solvents such as "high-test" gasoline, or as described in the Appendix. Even so, it often is cheaper to throw this "mud" away and

start over with clean liquid mercury. Where freezing prevents the use of simple water in seals, a calcium chloride solution of 1.3 s.g. or a half-and-half solution of 1.05 s.g. of ethylene glycol (while this is "prestone," the blue "prestone" emulsifies mercury too readily) may be used with safety down to, say, —15°F. Glycerine is sometimes used but has excessively high viscosity at low temperatures.

Pressure variations may cause a water-under-air manometer to pulsate so as to be unreadable while not appreciably affecting two-liquid types, hence the usefulness of carbon tetrachloride, bromoform, etc.

In using a manometer to determine the coefficient of a head meter, an excellent method is to take a large number of readings and obtain the average. With normal turbulence, the usual fluctuations of differential pressure are not large enough to cause any appreciable error, by reason of the square relation to the flow. Further, this method has the two advantages that readings can be repeated within a small fraction of one percent (say one-tenth to one-twentieth of one percent) and that such determinations give results practically identical with those of the usual integrating instruments having large masses of mercury that follow the mean differential head.

A practical laboratory combination comprises a barometric manometer with float and uniformly graduated legible differential scale and a small modern calculating machine that enables readings to be totaled and averaged with minimum loss of time. Such a machine will automatically count the number of observations as well as their total. A hundred or so readings may be taken in this manner for each calibration point and averaged immediately, permitting the final coefficient to be calculated as the test progresses, a procedure that would be impossible without these modern instrumental aids because of the prohibitive labor required by earlier methods. (Incidentally the 20-in. slide-rule is an excellent test companion, giving consistent values well within one-twentieth of a percent in the hands of a skilled user.)

(b) Standard Manometers

Specifications for the construction of U-tube and single-column Standards, and instructions or suggestions for their use as such, have been laid down by the Bureau of Standards and by engineering societies.

An important construction requirement (sometimes overlooked even in test work) is that the internal diameter should be large enough to minimize meniscus effects. For water columns, for example, a full inch diameter is necessary to avoid uncertainties.

For accurate results it is necessary (1) to take various precautions and (2) to make various corrections.

The more important corrections to be made are as follows:

1. Temperature coefficient of scale and of manometric liquid. Note that international agreement upon 68°F. (20°C.) has been reached.
2. Meniscus.
3. Local-value of gravitational constant.

These pertain only to the manometer. The errors due to failing to make such corrections are considerably smaller than "installation errors" resulting from failing to take into account factors wholly external to the manometer.

In § 5 of Ch. XVI, and in several appendices to this Part, there appear comprehensive data on these topics.

(c) Industrial Models

Industrial U-tube and single-tube head meter manometers are those which are designed especially for connection across specified differential producers or for use with specified Pitot tubes, and usually are calibrated accordingly. Factory calibration is particularly necessary in the case of two-liquid manometers.

In addition to these head meter instruments there are high-grade commercial differential pressure gages which are not primarily designed for such service but can be used for test work and also for checking mechanical and electrical head meter recorders.

Industrial glass manometers for metering service are characterized by various features seldom found in the commercial differential pressure gages. One is ability to withstand considerable static or line pressure. Another is some effective provision to prevent "blow-over" of mercury or other manometric liquid. Others pertain to ease of installation, minimizing of connection errors, etc. In many important respects, therefore, these instruments are to plain manometers what industrial thermometers are to etched-stem chemical thermometers.

Only a few of the commercially available manometers need be selected to illustrate the variety of forms and of features.

INSTANT KNOWLEDGE

of your flow conditions *with the*

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FLOW INDICATOR

Calibrated in any units you desire for *direct reading* of rate of flow in lines carrying water, oils, chemicals, air, gas and steam — pressures to 1000 lbs.

Close Hook-up Type

Two types — "Close" and "Remote" Hook-up.

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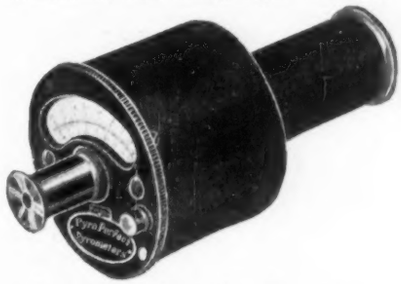
PYRO RADIATION PYROMETER

Self-Contained, Direct Reading, Rugged and Foolproof



Stop spoilage by getting the exact temperature of the work in the furnace—not merely the heat of the furnace.

Does not require a skilled operator. Strictly automatic.

No calculations—no chance for mistakes in judgment.

Always ready to tell within 3 seconds any short-comings in your equipment.

Weight 25 oz.; 7 inches long.

Temperature Range: 1000-3600° F.

WRITE ALSO FOR OPTICAL—IMMERSION SURFACE BULLETINS

THE PYROMETER INSTRUMENT CO.

103 LAFAYETTE ST. NEW YORK, N. Y.

CHEMIST: Graduate Hunter College 1918. Spent twelve years working out various chemical processes in the laboratory and demonstrating them from a practical standpoint in paper mills. Work in the laboratory has included water analyses, some bacteriological work, fibre examination, and testing of various materials. J-22.

ADVERTISING MANAGER: Also assistant sales manager of flow meter manufacturing company; available March 1. M.I.T. graduate Mechanical Engineer with 10 years shop, engineering, advertising and sales experience. J-23.

PHYSICIST: 2 years experience in research with particular training in atomics and electronics. Have held two fellowships. J-24.

COMMUNICATION ENGINEER: 10 years practical experience in installation, operation and maintenance of high frequency transmitters and receivers, also land line practice. Knowledge of Spanish. J-25.

ELECTRICAL ENGINEER: Experience with electric meter manufacturer and with an electrical testing laboratory. Master's degree in electrical engineering. J-26.

SALES ENGINEER: Sales promotion work on scientific instruments, industrial control, etc. Three years experience with manufacturer of scientific instruments and three years experience with manufacturer of automatic regulating devices. Graduate of University of Chicago. J-27.

ELECTRICAL ENGINEER: Graduate of University of Illinois with experience in development of control apparatus desires connection in research, design, or development of instruments or control apparatus. J-28.

SALES ENGINEER: B.S. degree, 1931, and graduate work in Physics and Chemistry, sales experience. Desires permanent connection with instrument manufacturer with opportunity to enter sales department. J-29.

MECHANICAL AND CHEMICAL ENGINEER: College graduate, experienced in general machine shop work, drafting. Three years as second assistant engineer in merchant marine. J-30.

SALES ENGINEER: Experienced in shop, service and sales. Interested in handling unit heat, ventilation and air conditioning apparatus. Licensed professional engineer. J-31.

METER SPECIALIST: 20 years experience with utilities and manufacturers. Meter, distribution and sales department. College education. J-32.

INSTRUMENT SALESMAN: Selling experience covers flow meters, CO_2 recorders; draft recorders and indicators; combustion and draft control; water and oil meters; electrical recording meters; watthour meters; testing devices and megohmers. J-33

RESEARCH ENGINEER: Technical Director, Chemical Engineer, Research Chemist, expert in paper, oils, dyes, chemicals, fuels, augment and improve production, cut costs, sales service, patents, literary work, 6 languages. Trained Harvard and abroad. J-34

MECHANICAL ENGINEER: 11 years experience in design, construction, sale, and servicing of power plant and industrial metering, regulating and control equipment. J-35

AUTOMATIC MACHINE DESIGNER: 15 years designing experience on automatic machines including 5 years, on boiler instruments, testing instruments and telegraph instruments. J-36

INSTRUMENT ENGINEER: B. S. degree 1925; four years with precision electrical instrument company in the research department. Specialized in resistance coil manufacture and constant temperature baths. J-37.

MATERIALS ENGINEER: 17 years' experience in the testing, preparation of specifications for and inspection of materials. For several years has been in charge of the materials testing laboratory of a large electrical manufacturing company. Desires immediate appointment. J-38.

The Venturi Manometer (Builders Iron Foundry) is of single-tube or "barometric" form; it stands more than six feet tall and has a glass 30 in. long, so that when used as a water-over-mercury manometer (its recommended use) it can indicate a differential head far in excess of 300 in. of water if necessary. Fig. 25-102 shows a number of features, some of them said to be unique. One interesting feature is a thin white line (of easily-cleaned celluloid) near the top of the float. This line is the "pointer" and it permits closer reading of mercury differential than is possible with the usual designs of simple U-tubes where well-rounded menisci lead to parallax errors when readings are taken hastily. The top of the B.I.F. float has a conical tip of soft rubber acting as an effective check-valve.

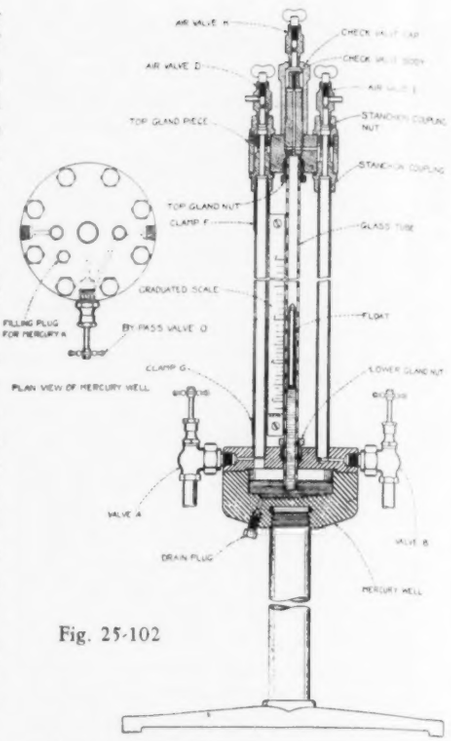


Fig. 25-102

Floats resting on the mercury reading column are a useful convenience in single-tube manometers, because they make possible locating the scale zero not only above the surface of the mercury in the well, but above the well itself, and therefore make possible a more compact design in which a leaky stuffing box cannot cause loss of mercury.

Fig. 25-103 shows the Mallen flow indicator (Statewide Engineering Co.) which is of exactly the same general type as the Venturi Manometer, in that it has a central mercury column with a float, but which was presumably developed especially for boiler-room applications and presents obvious contrasts

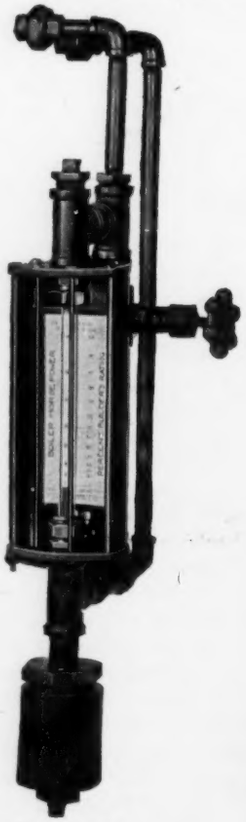


Fig. 25-103

Fig. 25-104

Fig. 25-105

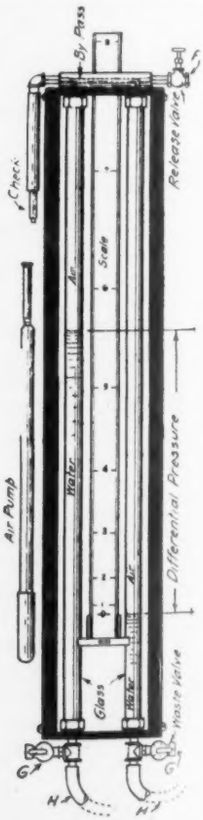


Fig. 25-106

in addition to the fact that it is designed for use with the maker's orifice plates. The scales of Mallen indicators for steam metering are marked "Boiler Horse Power" and "Percent Builder's Rating" (for boilers) or "Pounds per Hour." In addition to orifice plates, connecting piping and valves are furnished.

A side view of the Morey & Jones "Close Hook-Up" indicating flow meter, the primary device of which was described in § 10, is shown in Fig. 25-104. The secondary device is a single-column manometer without float but so arranged that when the by-pass is open for checking scale zero, the top of the mercury column is visible.

The Bailey Meter Company's "Type T-102" manometer, Fig. 25-105, has one reading column but comes closer in design to the conventional U-tube. It is designed to meet the demand for a portable indicating test manometer with 14-in. or 21-in. scale.

For metering water and other liquids, the inverted U-tube greatly simplifies both the installation and eliminates the necessity for converting the units in which the differential head is read, because it is read in linear units of the metered liquid itself. The Collins manometer (Arthur L. Collins) is ingeniously designed to be used either as a regular or inverted U-tube, and Fig. 25-106 shows it used as the latter for metering water flow by means of the Collins Pitot tube. Valve F is used to release enough trapped air to make col-

Fig. 25-107

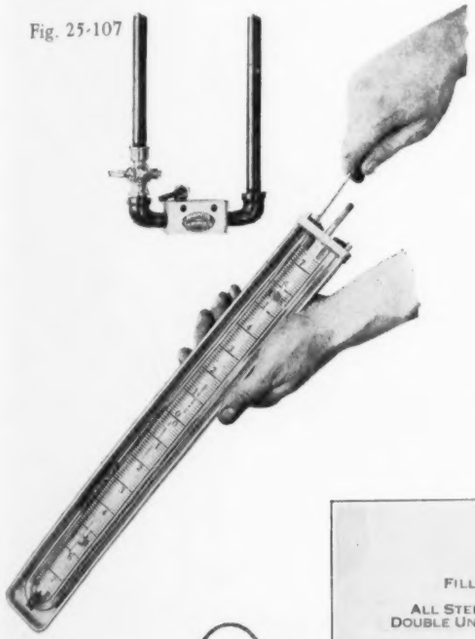
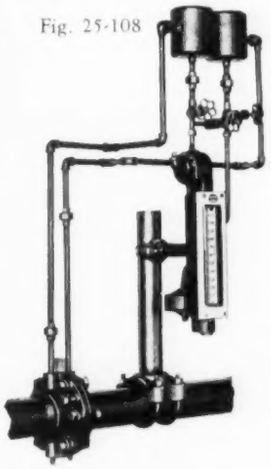


Fig. 25-108



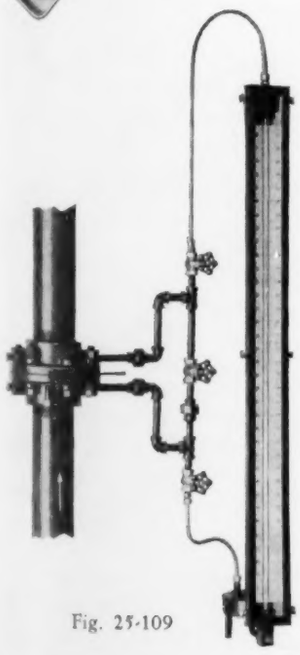


Fig. 25-109

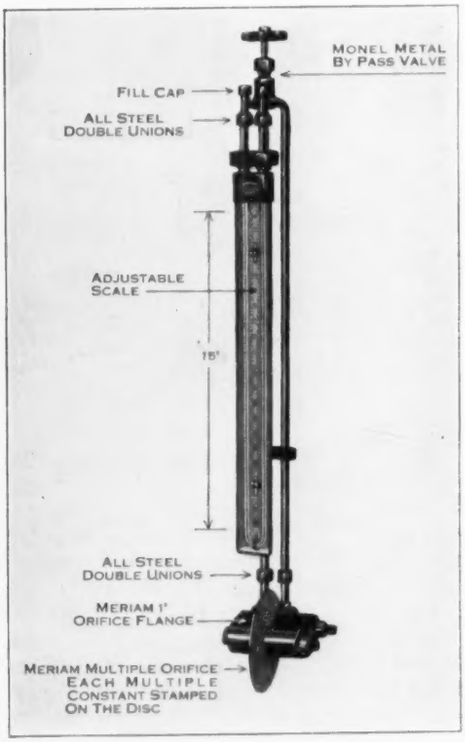


Fig. 25-110

MANUFACTURERS' LITERATURE

In this department we list each month the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

181 Stress Strain Recorder. A circular describing a recorder developed to record the stress and strain on testing machines. Baldwin-Southwark Corp., Paschall Station, Philadelphia, Pa. 3.1

182 Micro-Equipment. A 27 page catalogue entitled, "Ultropak" Micro-Equipment, which gives ultra illumination by incident light at all magnifications. Particularly adapted for the microscopic examination of living tissues. E. Leitz, Inc., 60 East Ohio St., N. Y. 7.7

183 Generators. Circular GEA-1607 describes direct-current generators and exciters, 1, 1½ and 2 Kw. Type B, recommended for general-purpose service and for field excitation. General Electric Company, Schenectady, N. Y. 13.2

184 Meter Testers. A broadside describing meter testers for stopping revenue leaks. H. W. Clark Company, Mattoon, Ill. 2.05

185 Resistance Units. Catalogue No. 5 describes the vitreous enameled resistance units. Ohmite Manufacturing Co., 636 North Albany Ave., Chicago, Ill. 4.1

186 Metal Tester. A leaflet describing a portable sheet metal tester, a practical testing device for every sheet metal user. Detroit Testing Machine Co., 5137 Trumbull Avenue, Detroit, Mich. 3.1

187 Freeness Tester. Folder No. 408a, a reprint from the "World's Paper Trade Review," May 8 and 15, 1931, entitled, "Beating and Freeness Tester," an apparatus for determining the freeness of paper, pulp, cellulose and mechanical pulp. Testing Machines, Inc., 314 Broadway, N. Y. 3.1

188 Experimenter. Vol. VI. No. 12, May, 1932, of this publication features the article, "New Measuring Instruments." General Radio Company, 30 State Street, Cambridge A, Mass. 5.2

189 Load Testing Devices. A catalogue dated May, 1932, on load testing devices for A.C. circuits. Western Electro-Mechanical Co., Inc., Oakland, Calif. 4.1

190 Gas Service Journal. April 1932 of this publication features: "Gas Measurement and Pressure Regulation at High Pressures"; Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa. 2.05

191 Telemetric Gauge. A pamphlet-catalogue describing the Kennedy Telemetric Gauge, for indicating distant pressures in gas distribution systems. J. S. Kennedy, 130 East 15th St., New York, N. Y. 2.05

192 Remote Pressure Recording Equipment. A pamphlet giving the purpose, advantages, price list and diagrams on the L. & N. remote pressure recording equipment. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. 2.05

193 Switches. Bulletin No. 12 comprises the lines of "Diamond H" flush, surface, rotary and special switches which are used for the control of lighting, heating, and special purposes. The Hart Manufacturing Co., Hartford, Conn. 13.2

194 Relays. A leaflet describing continuous current relays. Hart Manufacturing Co., Hartford, Conn. 13.2

195 Time and Temperature Control. Bulletin No. 13 describes automatic time and temperature control thermostats—electric range type. Hart Manufacturing Co., Hartford, Conn. 2.06

196 Remote Control Equipment. Bulletin No. 10 is devoted to the use of remote control switches with wiring diagrams and types of application, to further the knowledge of the use of switches. Hart Mfg. Co., Hartford, Conn. 13.2

197 Fog Horn. June 1932 issue of this publication features the article, "Care and Operation of ParkSpray High Duty Humidifiers and Psychrostats." Parks-Cramer Co., Fitchburg, Mass. 2.08

198 Meters. A catalogue announcing a new and greatly improved meter. The different types of cases in which the instruments can be furnished are also described and illustrated. Esterline-Angus Co., Indianapolis, Ind. 4.1

199 Microscope Equipment. Pamphlet No. 1199 describes ultropaque microscope equipment. Ultropaque designates ultra-illumination of opaque objects at all magnifications including oil immersions. E. Leitz, Inc., 60 East 10th St., New York, N. Y. 7.7

200 A Humidity Cabinet. A folder describing a new cabinet providing automatic control of temperature and humidity for aging cement samples in accordance with requirements of the American Society for Testing Materials. American Instrument Co., Inc., 774 Girard St., Washington, D. C. 2.08

201 Microscopes. A booklet describing and illustrating a new research microscope. Spencer Lens Company, 19 Doat St., Buffalo, N. Y. 7.7

202 Microscope Record. May 1932 issue of this publication contains the following articles: "On the Stability of Mounting Media"; "A Safe and Simple Method of Dehydration," "Triceratium," etc. W. Watson & Sons, Ltd., 313 High Holborn, London, W.C.1, England. 7.7

203 Rubber. "A Wonder Book of Rubber" is the title of a small paper book published by the B. F. Goodrich Co., Akron, Ohio, to reveal the story of rubber manufacture and use of rubber products. It is well illustrated.

204 Nofuse. Catalogue No. 2246 is a 76 page illustrated publication describing the operation, construction and application of each of the many Nofuse "De-ion" circuit breakers and includes prices for the various ratings. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 13.2

205 Meters. Bulletin No. 236A describes the diaphragm meter type GK which is used to register, indicate and record the flow of fluids. Builders Iron Foundry, Providence, R. I. 2.05

206 Micromax. A leaflet describing the micromax, an improved L. & N. potentiometer pyrometer. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. 2.06

207 The Laboratory. The feature article of Vol. 5, No. 3 of this publication is entitled, "A teacher who became a count." Fisher Scientific Company, 711 Forbes St., Pittsburgh, Pa. 8

208 Galvanometer. A booklet describing a moving coil galvanometer which is characterized by its very short period and which renders it useful for rapid observations, for measuring frequent fluctuations in electromotive forces, etc. P. J. Kipp & Zonen, Delft, Holland. 4.1

INSTRUMENTS, 3619 Forbes St., Pittsburgh, Pa.

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below:

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umns appear in the two legs. The scale is then adjusted until its zero is opposite the low column and the reading opposite the high column then shows the water velocity past the Pitot in the penstock. When the differential head is too high for the manometer, blow-over will occur and the water will simply circulate. In this case, the air pump is used at the check to break the overflow by re-separating the columns.

From the Meriam Company's extensive line of manometers designed especially for flow metering, a few selections show some interesting possibilities of the glass indicator when it is thoroughly "industrialized." Fig. 25-107 shows Model 392, the "clean-out" U-tube manometer, the body of which can be readily detached from its head. It comes in various sizes from 6-in. to 50-in., and can stand line pressures up to 500 lb. Fig. 25-108, an installation of the "Type E" Meriam orifice meter, shows the atomic welded connections, water seals for steam work, and a portion of the large-diameter mercury well (back of the lower part of the scale case). This "Type E" is further described in Part Four, Chap. XVII, § 4. Fig. 25-109 is the Meriam high-range manometer as installed across a Meriam orifice. This instrument is 42 in. long, is tested to 1,000 lb. hydraulic pressure, and has a plate glass cover in a frame of Allegheny metal. Scales are graduated individually for each user. Fig. 25-110 is the multiple-orifice flow meter assembly, the primary device of which was described in § 10, and the manometer of which is a 15-in. U-tube with atomic welded fittings.

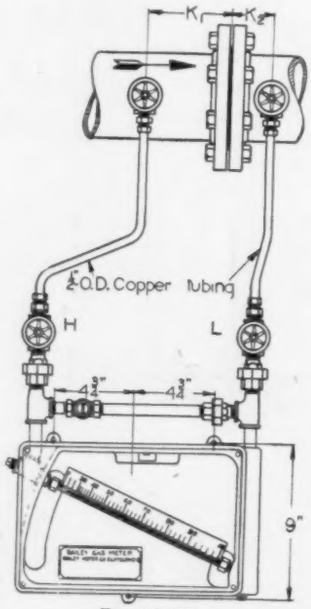


Fig. 25-111

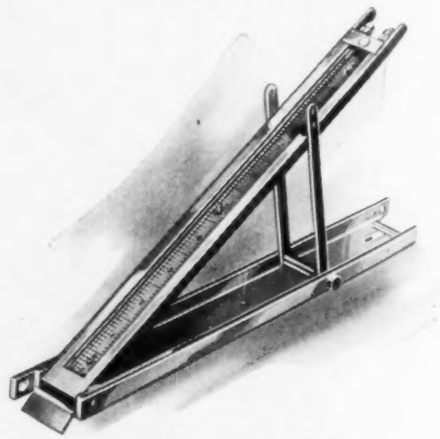


Fig. 25-112

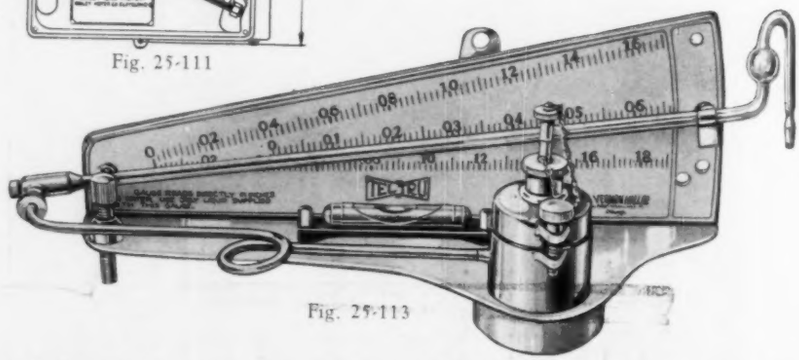


Fig. 25-113

Inclined-tube manometers of three strikingly different constructions conclude this section.

Fig. 25-111 shows a thoroughly "industrialized" form which constitutes part of an orifice type head meter. Mercury is used in this Bailey Meter Co. instrument for metering steam or water; while for low-pressure gas or air a colored oil is specified as the manometric fluid.

Fig. 25-112 is the American Blower Co.'s inclined U-tube manometer developed especially for use in fan-test work with the A.B.C. Pitot tube described in § 12.

Fig. 25-113 is a sensitive inclined tube instrument (almost a micromanometer) developed by the E. Vernon Hill Co. for precision aerological work such as measuring air velocity in rooms.

NEW INSTRUMENTS

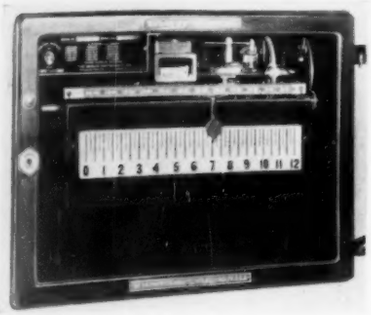
Recently Developed by Manufacturers

Write Information Section, Instruments Publishing Company, for additional Information.

Self-Balancing Indicating Potentiometer

Brown Instrument Company

A NEW indicating potentiometer of the self-balancing type is the latest addition to the potentiometer line of the above company. Among the design features of this instrument are an unusually long (40-inch) slide wire, positive spiral shaft drive, a non-slip clutch, a secondary pointer definitely fixing the size of step in moving the slide wire contact, interchangeable case for universal mounting, mechanism swings out of case for easy inspection without interference with operation, mercury-in-glass switches in control models, automatic thermal equalization between cold junction terminals and compensation coil, and many other construction and operating advantages of interest and value to potentiometer users.



A very distinct feature is the big scale with large figures, calibration marks and pointer, making accurate reading easy at a considerable distance. As a pyrometer this instrument can be supplied for any range from 0 to 100°F. up to 0 to 3,000°F. or for almost any span between these ranges. Models for automatically controlling as well as indicating temperatures are furnished where specified.

◆ ◆ ◆

Exposure Meter

J. Thos. Rhamstine

IN THIS new instrument, called an "Electrophot," a sensitive photocell is mounted inside a case. When the exposure meter is pointed at a scene or object, the photocell registers the amount of light reflected from it. A glance in the view finder shows the scene. Then a button is pressed, which closes a circuit created by two very small dry cells. Immediately the lens setting is shown directly on a dial which forms the face of the instrument.

Advantages claimed for this device over visual judging of exposure time are that no experience is necessary to estimate exposure time correctly; no faulty timing due to eye fatigue, and greater speed in determining exposure time.

◆ ◆ ◆

New Hand Tachometer

Amthor Testing Instrument Co.

THIS new direct reading hand tachometer for testing machine speeds incorporates the feature of automatic fixed reading. That is, the speed reading is automatically fixed on the dial after each time the instrument is used. On an ordinary centrifugal tachometer, the pointer always drops right back to zero after use. The readings may thus be lost, as the user has no fixed indication and must trust to memory. The pointer in this instrument does not return to zero. It stays fixed on the dial, and shows exactly what the speed was. It is not even necessary to reset the pointer when the next speed test is made, as the pointer leaves its present reading on the dial and points to the new speed reading.

With this new feature it is no longer necessary to keep the eyes focussed on the dial. Hence, the tachometer can be used in inaccessible places where it is awkward to hold and read the instrument at the same time. The dial is graduated directly in r.p.m. but the instrument is fully equipped so that all "feet per minute" surface and belt speeds can be taken. The tachometer has four separate speed ranges, each of which is separately read over the entire circumference of the dial. This serves to provide a great deal more graduation space, and consequently closer readings. Each is constructed with a balanced cross pendulum governor movement, is hand calibrated for accuracy, and dead beat in action. Various ranges can be had to indicate directly any speeds up to 12,000 r.p.m.

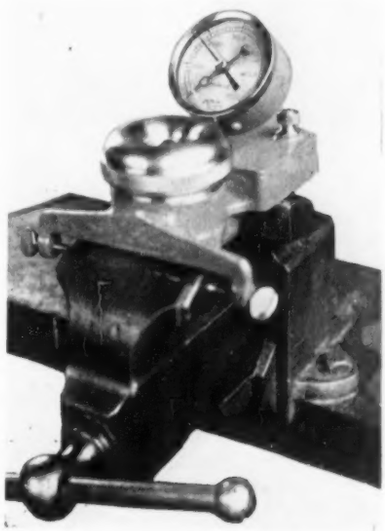
◆ ◆ ◆

New Portable Sheet Metal Tester

Detroit Testing Machine Co.

THIS simple and comparatively inexpensive device was designed primarily for the average shop requiring only occasional tests not warranting the purchase of expensive equipment but may also be profitably used in the larger plants. The standard cup test is used and the machine is ruggedly constructed for practical testing in the shop. It will be found valuable for determining the working qualities of material on hand or of incoming shipments.

The principle of operation of this tester is hydraulic. The specimen is clamped hydraulically as in the large machines manufactured by this company. This method insures uniform clamping as the clamping pressure is always in proportion to the load on the test punch. An ordinary bench vise is used for holding the tester and applying the pressure.



In operation a small specimen approximately 2½ in. square is placed in the machine and the cap screwed down lightly by hand. Closing the vise forces a small plunger into a cylinder on the bottom of the tester. This creates a pressure in the main cylinder, clamping the specimen and forcing the test punch through the material. The small plunger and main cylinder are so proportioned that a moderate pull on the vise handle will apply a load of 7,000 lbs. on the punch. This is more than sufficient to rupture 16 gauge stock.

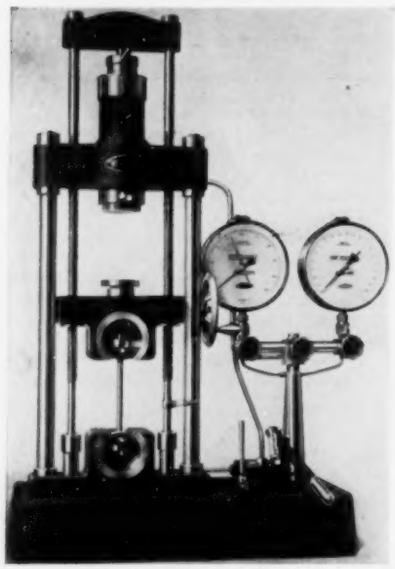
A suitable hydraulic gauge with a maximum pressure hand is mounted on the machine for indicating the load and a depth gauge reading in thousands of an inch is provided for measuring the depth of the cup. A test may easily be made in a minute and no previous experience is necessary.

Among other desirable features of this tester is its portability. A neat carrying case 8x10x10 in. is furnished and the total weight is only 20 lbs.

Universal Testing Machines

Steel City Testing Laboratory

A MODERATELY priced type of testing machine, as shown in illustration, for tension, transverse, bending and compression testing is being built by this company for foundries, sheet metal, wire, cable, and many other plants where a machine of low capacity (22,000 lbs.) will suffice for determining elastic limit, yield stress, tensile strength, etc.



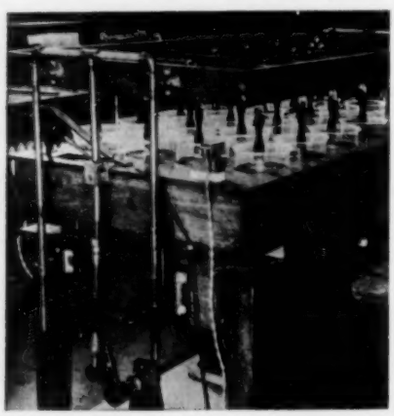
Outstanding features of this moderately priced apparatus are finely fitted non-packed plunger, vertical adjustability of the upper pulling head, two measuring ranges, space saving, convenient working height, and ease of operation. The machine can be supplied for hand or motor drive.

◆ ◆ ◆

Corrosion Testing Machine

Westinghouse Electric & Mfg. Co.

THE EFFECT of corrosion is becoming so important in welded boilers, pipes, containers for oil and chemicals that the research laboratories of this company are studying it with special apparatus. A special corrosion device has been built which greatly hastens the slow process of rust. In it the test specimens are subjected to intermittent immersions in a corroding liquid. The apparatus suddenly immerses the samples for a definite period, leaving them at rest, and then removing and exposing them to air for a definite period. They are moving only when being lowered or raised—a time which is a very small fraction of the cycle.



Samples are suspended from a rack by glass hooks, horse hair, or silk, and a motor-driven crank shaft raises and lowers the rack. The driving motor is controlled by a timing device composed of a synchronous motor operating a contact, which causes the motor to periodically turn the crank shaft a half revolution. The timing can be set for any cycle of test operation. To obtain reproducible results the corrosive liquids are kept at a constant temperature, by circulating water of a constant temperature along the outside of the vessels containing the corrosive liquids.

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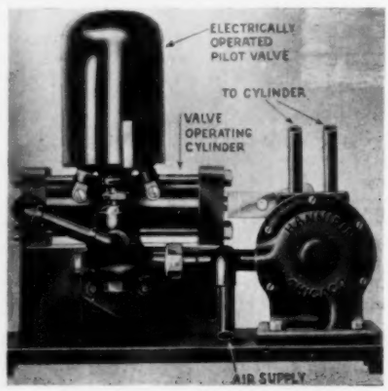
Electrically Operated Valve Unit

Hannifin Mfg. Co.

DESIGNED for time cycle operation or remote control of an air cylinder, this valve unit can be operated manually from a push button station, or automatically with an electrical time cycle unit.

The unit shown consists of:

1—An electrically operated pilot valve;
2—A single acting valve operating cylinder, and
3—A standard air control valve.



Closing the electric circuit causes the pilot valve to admit air to the valve operating cylinder, which in turn operates the air control valve, thus admitting air to one side of the power air cylinder. Breaking the circuit releases air from the valve operating cylinder, which, being a single acting spring return type, reverses the air control valve, thus admitting air to the opposite side of the power air cylinder.

This valve unit is designed for operating cylinders of 8 in. bore and larger where power stroke is to be held for a short period. Can be furnished with ¼ in., ½ in., or ¾ in. operating valve. It is furnished for operation on either a.c. or d.c. 110 volt circuit.

◆ ◆ ◆

Duplex Control Valve

Hannifin Mfg. Co.

THIS duplex valve has four independent outlet ports for control of two double-acting cylinders. It is so designed that two cylinders can be operated in either direction and in any sequence desired. For example—the valve can be connected with two cylinders resulting in the following order of operation: Starting with lever at one extreme position, then moving the lever 45° causes piston of cylinder No. 1 to move forward; moving lever an additional 45° causes piston of cylinder No. 2 to move forward; moving lever back 45° reverses cylinder No. 2 and moving lever to original position reverses cylinder No. 1.

Another example—with lever in neutral position both cylinders are reversed. Moving lever 45° to left causes piston of cylinder No. 1 to move forward. Returning to neutral position reverses cylinder No. 1. Moving lever 45° to right causes the piston of cylinder No. 2 to move forward. Moving lever to neutral position reverses cylinder No. 2.

The duplex valve is furnished in two sizes—one with ⅜ in. I. P. connections, and Model D-75 with ¾ in. I. P. connections.

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Reversing and Two Speed A.C. Manual Starters

Square D Company

TWO SPEED separate winding type and single speed reversing type starters for controlling across-the-line motors are recent additions to the line of A. C. manual starters manufactured by this company.

Both types have general application, but the two speed type is especially suitable for heating and ventilating purposes and similar installations where remote control is not essential.

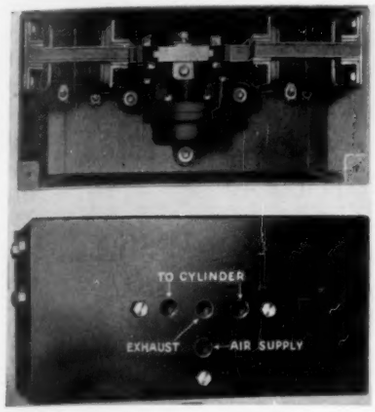
The maximum horsepower ratings of the three pole starters are 5 H.P. at 220 volts and 7½ H.P. at 440-550 volts.

Principal features of these starters are: front operation, thermal overload protection, operation of any relay opens main line completely disconnecting motor from line, two quick break switch mechanisms interlocked to prevent simultaneous operation, and push button reset without replacement of any parts after an overload.

Electrically Operated Valve

Hannifin Mfg. Co.

THIS electrically operated 4-way valve is suitable for a wide range of applications. It provides instantaneous push button control of air cylinders from one or more stations and can be used wherever a manually operated valve is now employed.



This valve incorporates the standard Hannifin "packless" disc type design of simple and sturdy construction.

The valve is operated by means of a double push button switch. Pressing the "start" button operates cylinder in one direction and pressing "stop" button reverses the cylinder. The cylinder is always under air pressure at one end or the other. The operation of the valve is instantaneous, therefore only momentary contact of the push button is required. The circuit is closed only when one of the push buttons is depressed. This valve may also be arranged for automatic time cycle operation by means of an automatic time switch.

This electrically operated valve is now available in two sizes with ¼ in. or ½ in. I. P. connections. Furnished for operation on 110-volt, or 220-volt, a.c. or d.c. circuits.

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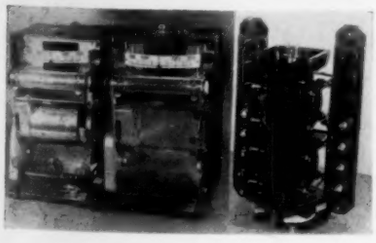
Graphic Instruments

Esterline-Angus Co.

BY ADDING many new and improved features to their recording instruments this company has brought out a complete new line of graphic electrical measuring devices. For example, the spring clocks which drive the chart are made of removable units, escapement, spring barrel and gear train. These interchangeable clock units can be quickly dropped out and replaced in the field, without putting the instrument out of service.



Another innovation is that all three springs in the clock are wound at one time by means of a simple crank, instead of the familiar clock key. This is done from the front of the meter, so that it is no longer necessary to space instruments apart on a switchboard in order to leave room for winding the clock.

Taking advantage of this fact, all instruments are arranged so that the rolls which drive the chart can be coupled together, accurately synchronizing the charts. The coupling is placed back of the gears which fix the chart speed, so that instruments operating at different chart speeds can be coupled up.

A complete assortment of electrical synchronous motor clocks are also offered for driving the charts. Both these and the spring clocks give chart speeds ranging from ¾ inches per hour to 12 inches per minute.

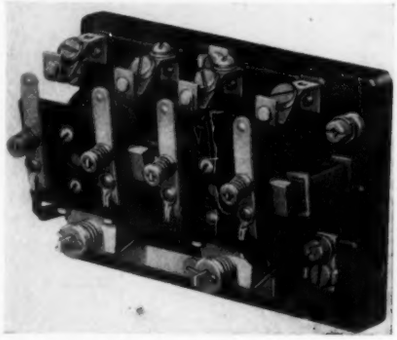
The entire line comprises 22 different kinds of recording instruments, including a.c. and d.c. ammeters, a.c. and d.c. wattmeters, a.c. and d.c. voltmeters, speed recorders, vacuum recorders, high and low pressure recorders, frequency and power factor recorders, time and production recorders, motion and position recorders, and water level recorders.

◆ ◆ ◆

New A.C. Reversing Contactor

Square D Company

THIS new a.c. reversing contactor, of small dimensions, is particularly adapted to small hoist, dumb waiter, window and door control. Contactors are mounted on a porcelain base, are mechanically interlocked, and have silver to silver contacts. The maximum rating is ¾ h.p., single or 3-phase. The dimensions are only 6 in. wide x 4 in. high x 3¼ in. deep.



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Watthour Meter

Westinghouse Elect. & Mfg. Co.

THE IMPROVED general design of the electromagnet in this watthour meter gives better performance, making for high accuracy from heavy overloads down to extremely light loads, and assuring better performance on variable voltage and temperature. Thermal capacity has been increased, and the starting watts reduced.

Primarily to provide for more thermal capacity in the current coils, the OC electromagnet has been enlarged. The one-piece lamination is retained, giving sturdy construction, to assure that the performance characteristics of the driving element do not change because of the shifting of parts.

The improved design has extended the range of the meter so that only three current ratings (5-, 15-, and 50-amperes) are required for self-contained loads. The 5-ampere meter starts on approximately 1 watt, and the 15-ampere model on approximately 3 watts, assuring registration of the smallest loads, such as electric clocks and door-bell transformers.

All OC single-phase meters have the same size base and terminals; and all parts except the nameplate, electromagnet, and register are identical and interchangeable in all ratings. The terminal chamber is arranged to fit meter trims of both 30- and 60-ampere switch boxes.

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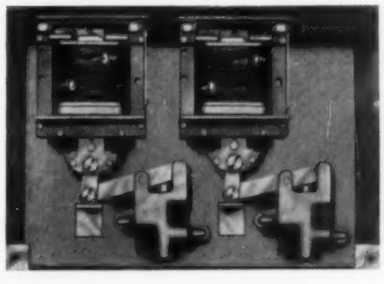
Electrically Operated Remote Control Valve

Hannifin Mfg. Co.

FURNISHED in both single and double types for remote control of either single-acting or double-acting air cylinders, this valve unit can be operated from one or more push-button stations. It is especially valuable for the application of air cylinders to engage and disengage clutches on large machinery where it is desirable to enable the operator to control the starting and stopping of the machine from a number of stations. When circuit is broken, cylinder is open to exhaust. These valves can be operated on 110 volt or 220 volt a.c. or d.c. circuits.

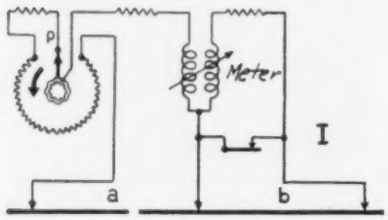


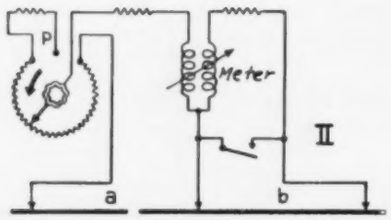
Rail Joint Tester

Hartman & Braun A. G.

THIS rail joint tester consists of a sensitive differential galvanometer and a collapsible contact stand. Only one man is required to operate this tester, the procedure of operation being as follows:

First the galvanometer is mounted on the head of the contact-stand, and fastened into place by clamping the three binding posts to the rigidly secured terminals of the contact leads. Then the contact frame is folded open by pulling the handgrip out of the top hole, bearing down on it, and inserting it into the lower hole. The contact arms are then rigidly mounted on either side. One next observes that the knurled button of the galvanometer be in position P (Diag. I), and then places the tester on the rail joint. In placing the contact stand over the rail joint, the joint must come under the contact arm marked "rail joint."





Placing one foot on the contact arm presses the contact-blades firmly against the rails. The middle blade is arranged with a spring, to take care of unevenness of the rail.

The power current in the rails serves as measuring current, so after unclamping the galvanometer, if a large deflection results, it indicates a high bonding resistance, or even an open circuit, at the joint. In that case the tester must be removed from the rail.

But should the galvanometer deflect only slightly from the zero point, one rotates the knurled button slowly away from position P till the meter pointer is brought back to zero. This operation at the same time automatically opens a short circuit switch, and the current branch b is switched into circuit (Diag. II). Then the reading of the knurled button indicates the rail joint resistance, using as a unit the resistance per meter of rail.

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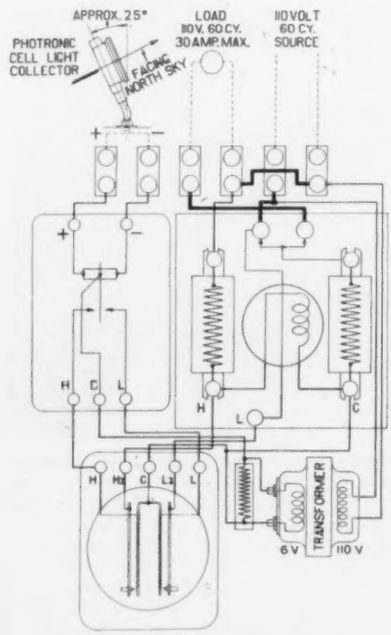
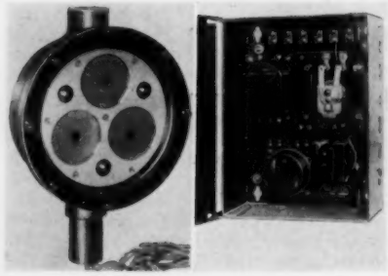
Illumination Control

Weston Electrical Instrument Co.

THIS illumination control consists of but two parts: (1) the light collector and (2) the relay cabinet. The light collector is the device containing the Photronic cells which is mounted on the roof facing the north sky or in the room, the illumination of which is to be controlled.





The relay cabinet contains all the relays necessary to control a circuit of 3000 watts at 110 volts. A Model 534 sensitive relay has its contacts adjusted to operate at a light level of 5 foot-candles minimum. A time delay relay is in the circuit between the sensitive relay and the power relay so that the contacts will not close when clouds pass over the sun and cause the lights to flash on and off. This time delay relay has a time element of about 1 minute which is ample to take care of daylight. The power relay is capable of handling 110 volt circuits up to 3000 watts capacity. A small transformer is supplied to provide the local circuit for the time delay relay.

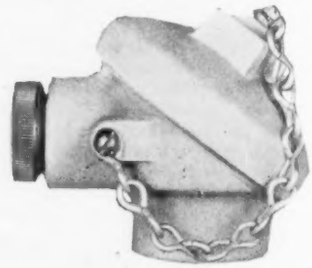
The equipment may be adjusted to operate at levels of light illumination intensity from 5 to 30 foot candles by a simple contact adjustment.

◆ ◆ ◆

New Universal Thermocouple Head

Leeds & Northrup Co.

THIS head is an accessory to thermocouple installations which makes for convenience in replacing the thermocouple element. A removable terminal block is provided, making connection of the leads convenient. Features of the case enclosing the terminal block are easy accessibility and provisions for keeping out moisture.



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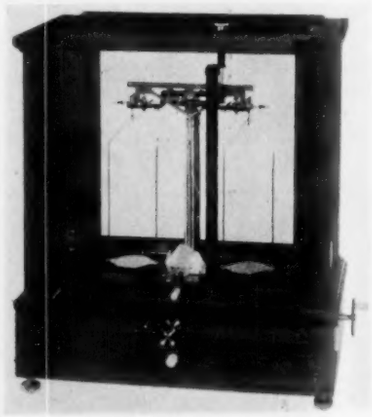

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Oftentimes an abstract can fit under two or even more sections. In that case we decide who will be most interested in the article, and include it under that field of reader interest. It is our aim to so arrange the abstracts that a person interested, for example, in viscosity, will keep in touch with all the important articles in his field if he reads only section 2.10. For instance, an article on "Vacuum Tube Means of Measuring Viscosity" appears under 2.10—under "Measurement and Control of Physical Properties—viscosity," although it would also fit under section (5.4)—"Electronic Devices and their Applications."

An improvement we hope to make in the Abstracts Section in the near future is the cross-indexing of articles which fit under several sections. We suggest glancing through the whole Abstract Section. This takes but a short time, and the time so taken will be found very profitably spent.

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Negative print photostats of the original articles abstracted can be obtained at 35 cents per page plus 10 cents for mailing. The remittance should accompany the order.

CLASSIFICATIONS

(By Fields of Reader Interest)

MEASUREMENT TECHNOLOGY (1)

This section includes all matters concerning the art and science of measurement as follows:

Measurement Theory (1.1)

Under this heading will be included: definitions, precision of measurements, systems of units, and dimensional analysis.

Measurement Practice (1.2)

Covers Calibration and Standardization.

Calculation (1.3)

This does not include computation for instrument design, but covers calculations as a mode of measurement.

MEASUREMENT and CONTROL (2)

This section is devoted to those general measurement practices and control applications that are not confined to any one industry or branch of engineering. Thus temperature measurement and control, being of as much importance in chemical as in metallurgical processes, is a general field of interest to all industries and all branches of engineering.

Length, Angle, and Area, Including Surveying (2.01)
Time, Speed, and Acceleration (2.02)
Weight, Density, and Specific Gravity (2.03)
Pressure and Vacuum (2.04)
Flow and Volume (2.05)
Temperature (2.06)
Heat and Combustion (2.07)
Humidity and Moisture (2.08)
Power, Work, and Output (2.09)
Physical Properties, (Viscosity, hardness, elasticity, plasticity, surface tension, etc.) **(2.10)**

TESTING and INSPECTION (3)

Physical Testing and Inspection (including strength tests, bending, magnetic analysis, X-ray inspection, and other engineering test or inspection methods.) **(3.1)**
Production Testing and Inspection (This includes methods of testing and inspection for setting up production standards, grading, gaging, maintaining quality, etc.) **(3.2)**
Maintenance Testing and Inspection (Included here will be matters concerning standards and methods for controlling performance or service of equipment. Example—The problem of controlling long phone lines to give quality sound transmission would be included here.) **(3.3)**

ELECTRICITY and MAGNETISM (4)

Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)
Electrical Measuring Devices and Applications (4.2)
Magnetic Measurements (4.3)
Magnetic Properties, Materials, and their Applications (4.4)

ELECTRONICS and RADIO (5)

Radio Measurements (5.1)
Applications of Radio to Measurement and Control (5.2)
Photo-electric Measurements, Devices and Applications (including television) **(5.3)**
Electronic Measurements, Tubes, Devices, and their Applications (Under this heading would be included thermionic tubes, grid-glow tubes, thyratrons, neon discharge tubes, cathode-ray tubes, etc.) **(5.4)**

ACOUSTICS and VIBRATIONS (6)

Sound, Vibration, Phenomena and Measurements (6.1)
Sound and Vibration Devices or Applications (6.2)

LIGHT, OPTICS, and RAYS (7)

Light—General Measurements and Optical Applications (7.1)
Color Analysis, Color Matching (7.2)
Photometry (7.3)
Polarimetry (7.4)

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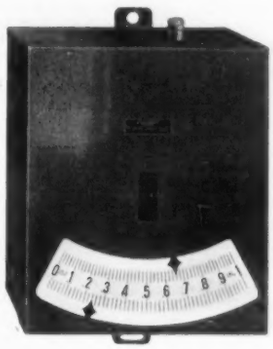

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Spectrometry (7.5)
Photography (7.6)
Microscopy (7.7)
Electromagnetic Rays (This heading covers all electromagnetic rays other than visible light: infra-red, heat rays, ultra-violet, X-rays, alpha, beta, gamma, cathode, and cosmic rays.) **(7.8)**

CHEMISTRY (8)
Under this heading will be chemical measurements, analysis, and their control applications.

ASTRONOMY, NAVIGATION, AVIATION (9)
Included in this section will be, besides usual matters concerning astronomy, navigation and aviation, special matter on direction-control such as range finding, direction finding, radio beacons, etc.

GEODESY, GEOLOGY (10)
In this section will be covered seismology, geophysical prospecting methods, etc.

INSTRUMENT DESIGN and CONSTRUCTION (11)
Matters concerning new instruments, their design, operation and manufacture, will be included under this heading.

GENERAL and MISCELLANEOUS (12)
This section will include: First; general items of interest to all in the field of measurement and control. Example—"Possibilities of Vacuum Tubes for Application to Measurement and Control" is an article of universal interest in the fields of measurement and control. Second; miscellaneous items of general interest because not includable under any of the above classifications. Finally, items of general interest to all fields of measurement and control, such as historical material, biographical, etc.
General (of interest to all in measurement or control fields) **(12.1)**
Miscellaneous (12.2)
Historical and Biographical (12.3)
Bibliographical (12.4)
Economic (12.5)

CONTROL FUNCTIONING EQUIPMENT (13)
Literature on the equipment used by operators or automatic controllers to perform their control functions will be covered under this heading. For example, the drum controller and associated switches, rheostats, relays, and motor starters by which an operator controls the motion of a crane are all pieces of "control functioning equipment."
Mechanical Control Functioning Equipment (13.1)
Electrical Control Functioning Equipment (13.2)
Includes drum controllers, relays, solenoids, etc.

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READERS' COMMENTS

To the Editor:

I have just received the February issue of your publication.

I am highly pleased with some of the enlarged features but I am disappointed to see that you have changed the physical dimensions. The approximate 5"x9" size made the book convenient to carry and file.

Your department of "Instruments Index" is of particular value to us in this remote location and I am sorry to note that you have omitted from these lists such notable manufacturers as Leeds and Northrup Co., Tagliabue Mfg. Co., and others.

This index to be of value to us here should include as complete a list of established and reliable manufacturers as possible whether they may or may not be paid advertisers in your publication. It appears to me that the Index is a service to your subscribers rather than a source of advertising.

Oroya, Peru — Floyd H. Viets, Engineer
March 16, 1932 — Cerro De Pasco Copper Corporation

To the Editor:

We have been readers of your publication, "Instruments," for the past year and wish to compliment you on its completeness and appeal to those interested in instrument application and manufacture.

Chicago, Ill. — James R. Harrington
April 20, 1932 — Howe Signal Company

To the Editor:

Am enclosing a request for a few of the trade publications listed in your current number of "Instruments."

Enjoy your magazine very much and find it extremely helpful in my work. I am engaged in a study of bullets and their motions in media denser than air and have had to develop more or less novel methods of chronographing rapidly moving projectiles. It was necessary to accomplish this without disturbing the bullet in any way so I am using photo-cells (the Weston Photronic Cell) in conjunction with a Standard Frequency Assembly and high frequency oscillograph. With a 25 foot base line my indicated accuracy over all is of the order of 1 in 3,000 or better with bullet velocities of around 3000 ft./sec.

Washington, D. C. — R. W. French
April 24, 1932 — Army Medical Museum, War Department

ELECTRONICS AND RADIO (5)

Photo-electric Measurements, Devices and Applications (5.3)

Photo-Electric Method to Determine the Turbidity of Liquids. (Photoelektrisches Verfahren zur Bestimmung der Trübung von Flüssigkeiten.) P. Jakuschoff. *Zeitschrift Verein deutscher Ingenieure*, Vol. 75, April 4, 1931, pages 426-428.

The current of a photo-electric cell changes according to the turbidity, concentration, or degree of coloring of liquids through which the light thrown on the cell passes. Differences not visible to the eye, but changing the indication of the cell, are due to violet rays which are invisible to our eye. Alkalipuctals for the cathode of the cell are especially sensitive for short waves, f.i. violet and ultra-violet rays. The arrangement of the instruments and a test is described; seven references are cited. Ha (5.3)

Light-Sensitive Relays Now on the Market. *Electronics*, Vol. 3, Nov. 1931, pages 194-195.

Brief description of a few tubes and selenium bridges. Ha (5.3)

Photo-Electric Tubes as Limit Switches. A. F. Bowers. *Electrical World*, Vol. 98, Aug. 29, 1931, page 386.

Photo-electric relays are used as limit switches on the run-out tables from the annealing and normalizing furnaces at the new jobbing sheet mill of the Worth Steel Co., Claymount, Del. The tables in the train are synchronized and run at exactly the same speed to prevent slipping and resultant scratching of the sheets in the transfer from one table to the next. After leaving the straightening rolls, the sheet travels to the end of the tilting table where it passes between a photo-electric relay and its light source. The relay stops the motors driving the rolls and the tilting tables, and starts the tilting motion. The light beam controls the travel of the sheet steel. The arrangement is illustrated. WHB (5.3)

Direct Measurement of Flux of Light by Means of a Photo-Electric Cell and Automatic Determination of Intensity of Light and Sorting of Incandescent Lamps. (Ueber objective Lichtstrommessung mittels photoelektrischer Zelle und über selbsttätige Bestimmung der Lichtausbeute bez. Sortierung von Glühlampen.) W. W. Loebe & C. Samson. *Elektrotechnische Zeitschrift*, Vol. 52, July 2, 1931, pages 861-866.

An arrangement is described which uses a photoelectric cell and an amplifier tube for the direct measurement of the luminosity of incandescent lamps of from 15 to 100 watts by means of an ordinary indicating instrument. The basic diagram of connection includes a photoelectric cell with a battery and a resistance; the voltage difference due to the photoelectric current across the resistance is connected to the grid and cathode of the amplifier tube. In the anode circuit lies the instrument the deflections of which are proportional to the light falling on the cell. A modification of this arrangement is used for the automatic determination of intensity of the lamp per watt, a photometering automat. The operation, calibration of, and experiences with this automatic device are fully described; a sorting machine built on this principle has been developed, which has been in service for several months. The accuracy of this measuring method is within ± 2%; 350 lamps could be measured in one hour. Ha (5.3)

LIGHT, OPTICS, AND RAYS (7)

Light—General Measurement and Control Applications (7.1)

A Chromatic Method of Making Optical Settings. D. S. Perfect. *Transactions of the Optical Society*, Vol. XXXI, No. 5, 1929-30, pages 249-251.

The paper describes a visual modification of a previously described photoelectric method of measuring small angles. Great simplification is introduced by the substitution of visual for photo-electric equipment at the sacrifice of sensitivity. Angular displacements are measured by means of a hollow prism previously described. The settings are made by causing an image of a fine slit to fall on the sharp edge of a steel prism. The two components of the divided beam, after being colored respectively red and green, are recombined, and a visual method is employed to observe the resulting color. The relative position of the prism edge and image determines the proportion of red and green and is very sharply defined by the position of best resultant yellow. The settings have average errors of 0.2 second and are less fatiguing than cross-wire settings. (7.1)

New Optimeter with Increased Sensitivity. (Neues Optimeter mit erhöhter Empfindlichkeit.) F. Loewin. *Mechanik und Präzision*, Vol. 39, April 1, 1931, pages 14-16.

The usual optimeter of Zeiss, which in fact is an optical lever for measuring differences in distances, thicknesses, etc., has a ratio of 1:1000; that is 0.001 mm. appears in the field of vision as 1 mm. The new instrument uses a pair of mirrors with double-reflection, one following the movements of a little point and movable against the other stationary mirror. In this way a ratio of 1:4700 could be obtained, which means that about 0.0002 mm. appear as 1 mm. in the field of vision. The instrument is described in detail and its application for measuring and verifying of gages illustrated. Ha (7.1)

A Plane-Parallel Plate Refractometer. A. H. Pfund. *Journal Optical Society of America*, Vol. 21, March 1931, pages 182-186.

A simple arrangement for demonstrating critical angles, total internal reflections, etc., consists essentially of a plane-parallel glass plate of about 10 cm. x 10 cm. x 0.5 cm. The lower surface is coated with white paint. From above a brilliant "point-image" of an automobile head-light is projected on the glass-paint interface; this image acts as a new source of light, sending out rays in all directions. At the angles of emergence equal to or greater than the critical angle all rays are returned to the lower white surface, thus producing an illuminated area with a black circular disc in the center. From the plate and disc diameters the refractive indices can be calculated from the formula which is given. A few photographs illustrate the method. Ha (7.1)

THE REVIEW OF SCIENTIFIC INSTRUMENTS

CONTENTS FOR JULY, 1932, ISSUE

VOL. 3, NO. 7

The Design of Temperature Control Apparatus for Piezo Oscillators.

A Machine for the Graphical Study of the Composition of Simple Harmonic Motions.

Reciprocal Lattice Projecting Ruler and Chart.

A Vibrating Reed Oscillograph.

A New Method of Measuring Contact Potential Differences in Metals.

Determination of Quality as a Basis for Commodity Standards.

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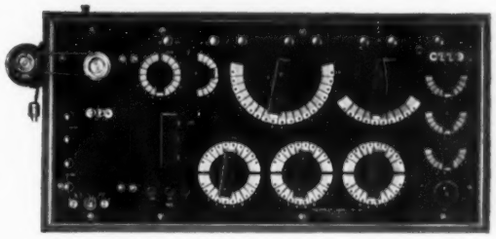

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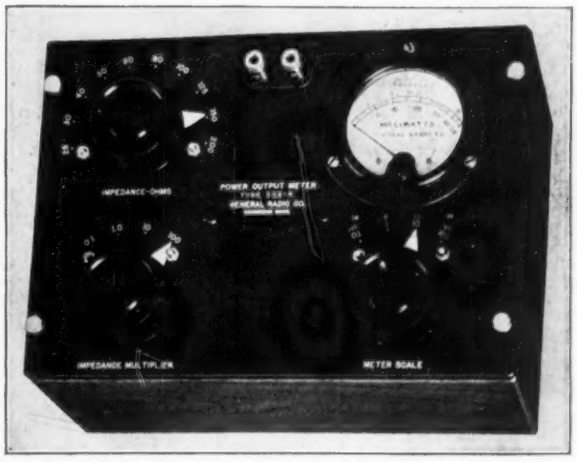

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Properties of Glass in Dependance on Pre-Heat Treatment. (Ueber die Abhängigkeit der Glaseigenschaften von der Wärmevorgeschichte.) E. Berger, *Zeitschrift für Instrumentenkunde*, Vol. 51, March 1931, pages 127-136.

Treats of the influence of cooling speed upon the properties of optical glass. Paper was presented before the Deutsche Glastechnische Gesellschaft, London, 1930. EF (7.1)

Terminology in Optics. (Zur Bezeichnungsfrage in der Optik.) H. Boegehold & M. Herzenberger. *Zeitschrift für Instrumentenkunde*, Vol. 51, Jan. 1931, pages 47-54.

Long list of designations, abbreviations, signs, terms, definitions submitted by a Committee to the Gesellschaft für angewandte Optik, Oct. 1931. EF (7.1)

Measurement of Fiber Diameters by the Diffraction Method. H. J. McNicholas & H. J. Curtis. *Review of Scientific Instruments*, May 1931, pages 263-286.

The classification of wool fibers into standard grades is based entirely on the average diameter of the fibers. The diffraction of light by a bundle of parallel fibers was employed by Thomas Young in 1842 in a simple ingenious instrument for the rapid direct measurement of average diameter, but no thorough investigation has ever been made of the practical possibilities of this method in the routine grading of wool. In the present paper a new construction of Young's instrument (the eriometer) is described, and a critical study is made of the accuracy and adaptability of the instrument in the averaging of a wide range of diameters as distributed in a group of fibers. Sources of error and limitations of the method are discussed. It is found that the eriometer average is in excellent agreement with comparable data obtained with the microscope. The method affords considerable opportunity for the further development of instruments to include additional features desirable in the study of wool or other textile fibers. (7.1)

Calibration of Abbe Refractometer with Compensating Prisms, to Measure Refractive Index for Any Wave Length. L. E. Dodd. *The Review of Scientific Instruments*, Aug. 1931, pages 466-501.

A method of so calibrating the refractometer as to read index for any wave length and for any setting of the compensating prisms has been worked out. The derivation of the necessary equations and the procedure are given in this paper. (7.1)

Optics in Metal Working. Ken G. Nieback. *American Machinist*, Vol. 75, Aug. 6, 1931, pages 225-228; Aug. 13, 1931, pages 272-273; Aug. 20, 1931, pages 307-309; Aug. 27, 1931, pages 346-347; Sept. 3, 1931, pages 380-382; Dec. 24, 1931, pages 962-963.

This series of articles explains the fundamentals of optical systems, magnification, deflection, refraction and describes in detail the instruments for testing materials and processes, such as micrometer microscopes, spectroscopes, contour projector, optical drill gage and optical flats. Ha. (7.1)

The Interferometric Determination of Refraction Indices of Diluted Solutions. (Die interferometrische Bestimmung der Brechungsindices verdeunnter Loesungen.) A. E. Brodsky & J. M. Scherschewer. *Zeitschrift für physikalische Chemie, Section A*, Vol. 155, No. 5/6, Aug. 1931, pages 417-430.

A new interferometric method has been developed for the determination of the refraction indices of diluted solutions. The accuracy of the new method exceeds by far the accuracy of the refractometer generally employed, which particularly holds true in the case of great dilutions. Errors due to the limits of accuracy are theoretically treated and experimentally confirmed. The diffraction indices of 0.1 and 0.004 N solutions of KCl and KNO_3 were determined with three different wave lengths and at two different temperatures. EF (7.1)

A Spectro-Helioscope. (G. E. Hales Spektrohelioskop.) W. Grotrian. *Zeitschrift für Instrumentenkunde*, Vol. 51, May 1931, pages 438-439.

Reviews instrument adapted for the measurement of motion effects on the sun or in the surrounding atmosphere which happen in short intervals and at a considerable speed. EF (7.1)

Interferometer According to Zehnder-Mach. (Ueber ein Interferometer nach Zehnder-Mach.) G. Hansen. *Zeitschrift für technische Physik*, Vol. 12, Aug. 1931, pages 436-440.

A four-plate interferometer 20 cm. diameter and a maximum mirror distance of 100 cm. is described. The instrument is brought on the market by the C. Zeiss Co., Jena. EF (7.1)

Measurement of Smoke Density on Optical Basis. (Rauchdichte-Messung auf optischer Grundlage.) Jos. Kroenert. *Archiv für Technisches Messen*, 1931, section V1286-2, page T5.

Beside direct observation and photographing the smoke emitted from a chimney, an actual qualitative measurement can be made by a light-sensitive arrangement, as a photocell, bolometer or vacuum thermo-couple. The degree of density is measured arbitrarily by the Ringelmann scale, which consists simply of six differently shaded standards from transparency to absolute blackness; these degrees are recorded on the chart. The instruments are calibrated in grams of particles in one cubic meter. The theory of the optical measurement of smoke-density is explained, and a list of literature references added. Ha (7.1)

A New Na-Source of High Light-Density. (Eine neue Natriumlichtquelle mit hoher Leuchtdichte.) M. Reger. *Zeitschrift für Instrumentenkunde*, Vol. 51, Sept. 1931, pages 472-476.

The necessity of developing a useful source of monochromatic light for optical instruments is stressed. The Na-vapor discharge lamp introduced by Prof. Pirani at the Meeting of the Deutsche Gesellschaft für technische Physik 1931, is described at length. EF (7.1)

Optical Testing of Glass for Inner Stresses by Polarization. (Optische Glasprüfung durch Polarisation auf innere Spannungen.) Bodo Voigt. *Archiv für Technisches Messen*, 1931, section V931-3, page T28.

The origin and nature of faults in glasses are discussed and examples for inner stresses given. The connection of double-refraction and tension is explained and the detection by the Lummer-double rings and other methods described. Ha (7.1)

Measurement of Double-Refraction. (Messung der Doppelbrechung.) Bodo Voigt. *Archiv für Technisches Messen*, 1931, section V44-1, pages T23-24.

The nature of double-refraction in crystals is explained and the usefulness of this phenomenon for measuring the properties of transparent bodies pointed out. The electro-optic Kerr effect, magnetic Cotton-Mouton effect, the methods for determining double-refraction and the application of double-refracting crystals for the alternation of the vibration of light are described fully. Ha (7.1)

Interference of Light as Basis of Interferometric Measurement. (Interferenz des Lichtes als Grundlage für interferometrische Messung.) Bodo Voigt. *Archiv für Technisches Messen*, 1931, section V47-1, page T51.

Based on the electromagnetic theory of light, the nature of interference phenomena is explained; they can be observed by lenses and mirrors. The methods of measurement are described briefly. Ha (7.1)

On Reflecting and Transmitting Media, Their Investigation and a New Measuring Instrument for this Purpose. (Ueber reflektierende und transmittierende Stoffe und deren Untersuchung, sowie ein neues Messgerat hierfuer.) R. G. Wigan & W. Ott. *Zeitschrift für Instrumentenkunde*, Vol. 51, Jan. 1931, pages 1-19, Feb. 1931, pages 61-77.

The paper presented before the Deutsche Beleuchtungstechnische Gesellschaft und Gesellschaft für angewandte Optik, Berlin, 1930, takes the following steps: I. The significance of light-reflecting and light-transmitting media with particular reference to the light-technique. II. On the properties of reflecting and transmitting materials and the scope of investigating the latter. III. History of experimental research work spent on reflecting and transmitting media. IV. A new installation for the experimental investigation of the phenomena associated with light-reflection and transmission. V. The accomplishment and evaluation of measurements gained with the new equipment. The new installation is fitted for carrying out reflection, transmission and absorption measurements on solid bodies, powders and liquids, applies parallel light beams of high intensity during a long period of testing time, and permits measurements in diffuse light. The angle of incidence of the light beam can be varied between a perpendicular and an acute incidence. The amount of total reflection, total transmission and total absorption can be determined with the new equipment, which may also separate the regular from the diffuse reflection and transmission respectively. The various features of the speaker's outlay are described at length and given by several of the 24 illustrations included. The paper also contains a great number of references. EF (7.1)

Color Analysis and Matching (7.2)

Photo-Electric Cell Has Definite Place in Color Measurement. W. M. Scott. *Textile World*, Vol. 79, Feb. 21, 1931, pages 18-21.

The article describes the uses, the present limitations, and the future possibilities of the photo-electric cell for the textile industry. GN (7.2)

The Unit of Photographic Intensity, the Present Status of its International Standardization. Loyd A. Jones. *Journal Optical Society of America*, Vol. 21, June 1931, pages 361-368.

A critical review on the present state of the unit for photographic intensity. Recommendations for relative energy values of wave lengths and compositions of liquid absorbing filters are made, and it is pointed out that a unit in which the intensities of light sources are to be expressed and the quality of light to be used must be specified by international agreement. Ha (7.2)

Dictionary of Color. M. Rea Paul. *Journal Optical Society of America*, Vol. 21, June 1931, pages 358-360.

The National Lead Company Research Laboratories have published a dictionary of some 7000 color samples which is intended as a reference for those who seek to relate colors with names by which they are commonly identified. They are divided into nine groups, in which all the colors intervening between the terminal colors of the respective group are found on single color plates. Ha (7.2)

Color Specification in the Pulp and Paper Industry. W. B. Van Arsdel. *Journal Optical Society of America*, Vol. 21, June 1931, pages 347-357.

Discussion and description of some methods in use in the paper industry for the determination of color and roughness of papers and pulps. Ha (7.2)

Spectrophotometric Measurements in the Dyestuffs Industry. C. Z. Draves. *Journal Optical Society of America*, Vol. 21, June 1931, pages 336-346.

The usefulness of spectro-photometric measurements in the manufacture standardization, sale, and use of dyestuffs is discussed. For chemically pure dye or for dyes simply diluted with other colorless substances the spectro-photometric method is entirely sufficient for determination of strength. This condition is, however, actually only seldom met with. Spectral absorption measurements have to be employed in addition when measuring strength of dyes of different provision. The spectral absorption can be measured the more quickly by reading each dye solution only at the maximum of absorption instead of the whole absorption curve. It is further pointed out that for many purposes, direct visual examination can be made just as satisfactorily and cheaply as with an optical instrument. Ha (7.2)

Reflectance Measurements in the Paint Industry. G. F. A. Stutz. *Journal Optical Society of America*, Vol. 21, June 1931, pages 323-335.

A brief sketch of the colorimetry story of paints is given and an outline laid down for standardization methods of determining paints. The factors on which the appearance of painted surfaces depend are: amount and spectral distribution of the diffusely reflected light, the amount of the specularly reflected light (the gloss), and the total (integrated) reflectance. At present, no absolutely satisfactory instrument exists which permits to measure these factors quickly and economically, although photometer and spectrophotometer can be used reasonably well. Ha (7.2)

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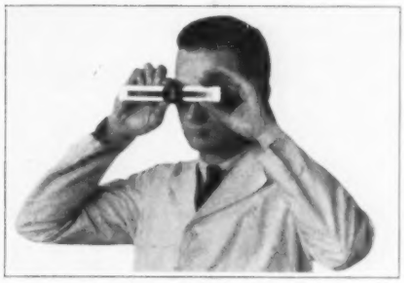

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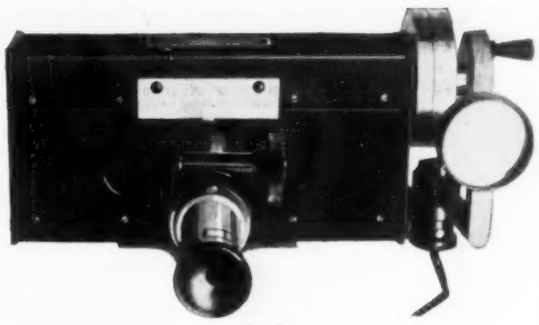

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Color Measurement in Psychological Terms. DOROTHY NICKERSON. *Journal Optical Society of America*, Vol. 21, Oct. 1931, pages 643-650.

The author explains the principles of color measurement of agricultural products used in the Bureau of Agricultural Economics. The three color attributes, hue, brilliance and saturation (or chroma) are represented by a color solid in which brilliance is the vertical dimension, chroma or saturation the horizontal dimension, and hue is shown in an angular direction. Examples and curves taken illustrate the method. Ha (7.2)

A Colorimeter for Use with Disc Mixture. DOROTHY NICKERSON. *Journal Optical Society of America*, Vol. 21, Oct. 1931, pages 640-642.

The instrument was developed by Keuffel & Esser to measure the color of agricultural products—hay, cotton, fruits, grains, etc. It expresses the result in terms of hue, brilliance, and chroma; it can be adjusted to measure a small or large area, and it measures the average color of a highly variegated surface. The color is determined by the use of disc mixtures of Munsell papers. Ha (7.2)

Principal Remarks on the Principles Involved in the Method of L. Bloch for Color-Measurement. (Grundsaetzliches ueber das Farbenmessverfahren von L. Bloch.) H. PESE. *Zeitschrift für technische Physik*, Vol. 12, Aug. 1931, pages 418-421.

After considering the Bloch and Oswald method of color measurement the sources of errors of any measuring method employing filters are critically discussed, and in particular the sources of error associated with the Bloch method are considered. The author proves that data from experiments according to Bloch cannot be transferred into Oswald's data. Due to its valuable fundamental principle, Pese urges further work on the Bloch method with the goal of rendering this method into a commercially valuable way of color measurement. EF (7.2)

Polarimetry (7.4)

Replacement of the Gas-Sodium Lamp by Filtered Electrical Light for Polarimeter Illumination. (Ueber einen Ersatz der Gas-Natriumlampe fuer Polarimeter-Beleuchtung durch gefiltertes Licht.) C. WILHELM. *Chemiker Zeitung*, Vol. 54, March 8, 1930, page 194.

Author reports on his experiments to replace the gas-sodium lamp and gives the various combinations tested, mainly referring to electric bulbs and light filters. EF. (7.4)

Measurement of Polarization. (Polarisations-Messung.) BODO VOIGT. *Archiv für Technisches Messen*, 1931, section V45-1, pages T43-44.

The nature of polarization is explained and the methods of producing polarized light described. The rotation of the plane of polarization and the methods for its measurement with monochromatic and white light are explained Ha (7.4)

Spectrometry (7.5)

A Synchronous Film Drum for Recording Periodic Spectra. DOLAND C. STOCKBARGER & CARL G. SELIG. *The Review of Scientific Instruments*, Vol. 2, April 1931, pages 211-216.

The inadequacy of the shutter method is pointed out. A rotating film drum, run at synchronous speed, is declared best for the study of extremely intense transient spectra. The drum described was designed and constructed to replace the plate holder of a Hilger E2 quartz spectrograph. A spectrographic record covering the full 360° phase interval is obtained in about the time required to make a single photograph by the shutter method. Some loss of definition results from the fact that the surface of the film cannot be curved about a vertical axis as is that of a plate in the plate holder, but by bringing the lines into focus at wave lengths around 2400 A and 4000 A the entire spectrum is made sufficiently sharp. Time marks at 90° intervals are printed on the film when required by means of an iron or copper spark gap placed in front of the spectrograph slit. Many uses for the apparatus have already been found, some of which are illustrated in several figures accompanying the article. MFB (7.5)

A Self-Recording Spectrometer. H. M. RANDALL & JOHN STRONG. *Review of Scientific Instruments*, Vol. 2, Oct. 1931, pages 585-599.

This is a detailed description of an instrument which can record lines of band spectra as far out as 26 A. It is fitted with a prism train containing both a 60° and a 30° prism, and, as it is to be used in the infra red range, prisms of KCl, KBr and KI made of large single crystals. For the recording a thermopile receiver is employed, similar to that used in the recording microphotometer. To exclude disturbances as much as possible the whole instrument is enclosed in an evacuated chamber, so that the entire optical path from the emitting source to the receiving thermopile is in a high vacuum. Ha (7.5)

A Twenty-One Foot Vacuum Spectrograph for the Extreme Ultraviolet. GEO. R. HARRISON. *Review of Scientific Instruments*, Vol. 2, Oct. 1931, pages 600-610.

The construction of a vacuum spectrograph containing a six-inch concave speculum grating of 21 ft. radius of curvature is described. Exposures of one hour suffice to give satisfactory spectrograms having a dispersion of 2.7 A per mm. in the first order, the entire range 2000-1000 A being recorded at one setting on a 16-inch plate. By means of a vacuum-tight screw up to 30 exposures can be taken on a single plate, and introduction of a stop-cock in the slit-tube permits source and slit to be changed at will. A gate is provided to admit air to the 40-liter camera box without destroying the vacuum in the 830-liter body of the spectrograph, for the change of plates. Arrangements with three 4-stage Gaede diffusion pumps evacuate the instrument in an hour from atmospheric pressure to below 10^{-4} mm. The instrument possesses a high resolving power in hot spark spectra; its main purpose is to enable intensity measurements to be made satisfactorily in the Schumann region. Ha (7.5)

A Spectrograph-Plate Shield. J. TRACY LAY & I. CLYDE CORNOG. *Review of Scientific Instruments*, May 1931, pages 293-296.

A shield designed for use in a spectrograph to prevent pre-exposure and subsequent exposure of the photographic plate due to scattered light when a number of spectra are photographed on the same plate or film. The use of such a shield eliminates consequent errors in the densities of spectral lines as determined by a densitometer. (7.5)

Measurement of Astigmatism of Skew Pencils. (Messung des Astigmatismus schiefer Buendel.) B. E. MOURASHKINSKY & P. P. ARTAMANOFF. *Zeitschrift fuer Instrumentenkunde*, Vol. 51, March 1931, pages 159-160.

Collimator of spectrometer was replaced by the main part of a maximum diffraction value meter. E.F. (7.5)

Utilizing Systems of Largest Possible Numerical Aperture as Objectives for Brightly Illuminated Spectrographs. (Zur Frage der Verwendung von Systemen moeglichst grosser numerischer Apertur als Objektive fuer lichtstarke Spektrographen.) W. KRAEMER. *Zeitschrift fuer Instrumentenkunde*, Vol. 51, April 1931, pages 204-205.

Graphical evaluation. Sensitivity 1½°A.U. Table containing some values. E.F. (7.5)

Photography (7.6)

The Maximum Convergence of the Axes of the Photographic Cameras for Stereo-Photogrammetry. (Ueber die maximalen Konvergenzen der Kamera-Achsen in der Stereophotogrammetrie.) E. WOLF. *Bildmessung und Luftbildwesen*, Vol. 6, No. 1, March 1931, pages 20-22.

Theoretical considerations show that the maximum convergence depends greatly on the nature of the terrain and its covering (woods, meadows, etc.), but that the convergence must not be very great, as otherwise the stereoscopic evaluation might become impossible. For isolated exposures a convergence can be used to good advantage; for series exposures, however, overlapping of at least 50% is to be preferred to make orientation from one plate to the other plate easier. Ha (7.6)

A Falling Plate Flashometer. W. E. FORSYTHE & M. A. EASLEY. *Review of Scientific Instruments*, Vol. 2, Oct. 1931, pages 638-643.

Detailed description of an instrument to determine the characteristics of flash powders and flash lamps. Ha (7.6)

The Fac Simile Automatic System of Siemens & Halske. (Der reproduktions automat System Siemens & Halske.) KIESSLING. *Allgemeine Vermessungsnachrichten*, Vol. 43, Oct. 28, 1931, pages 673-677.

This apparatus automatically reproduces maps, charts, surveying plans, etc. The photographing, cutting, developing and drying is all done automatically. Pictures of 148x210 cm. are made; every 12 seconds an exposure can be made. A complete print requires 10 minutes. The price of the outfit varies from Mk 1160 to 7500, according to size. Ha (7.6)

Contribution to the Introduction of Uniform Designations in Photogrammetry. (Beitrag zur Einführung von einheitlichen Bezeichnungen in der Photogrammetrie.) P. WERKMEISTER. *Bildmessung und Luftbildwesen*, Vol. 6, No. 1, March 1931, pages 12-15.

Suggestions for uniform definitions of instruments and methods used in aerial photography. Ha (7.6)

The Application of Stereo-Photogrammetry in Architectural Measurements. (Ueber die Anwendung der Stereophotogrammetrie auf Architekteroermessungen.) K. SCHWIDEFSKY. *Bildmessung und Luftbildwesen*, Vol. 6, June 1931, pages 69-73.

General discussion of method and principles for taking exposures and evaluating them. Ha (7.6)

A Pantograph for Enlarging X-Ray Photographs. C. J. KSANDA. *Review of Scientific Instruments*, Vol. 2, May 1931, pages 305-306.

The device is intended to facilitate the enlargement of X-ray spectrum photographs and to make the evaluation more accurate. Ha (7.6)

Inexpensive Diapositives. (Wohlfeile Diapositive.) P. KASPARECK. *Elektrotechnische Zeitschrift*, Vol. 52, July 9, 1931, page 908.

Can be made of cellophane which is placed between glass plates. Ha (7.6)

Improvements and Supplements on the Hugershoff-Heyde Photogrammeter. (Abänderungen und Ergaenzungen an einem Hugershoff-Heydeschen Photogrammeter.) H. LOESCHNER. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, July, 1930, pages 416-423.

Devices embodied in the novel instrument of the Aerotopograph Co., Dresden, according to the author's suggestions. E.F. (7.6)

Microscopy (7.7)

A New Dark Field Microscope Illuminator for Opaque Objects Producing Annular, Cross-Fire, and Indirect Illumination. JOHN J. GERLACH, JR. *Review of Scientific Instruments*, Vol. 2, July 1931, pages 412-415.

An exact description of the optical arrangement with photographs of a few objects. Ha. (7.7)

Instrument for Measuring Displacements in the Direction of Observation. (Ein Apparat zur Messung von Verschiebungen in der Sehrichtung.) W. LINNIK. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, March 1930, pages 192-194.

Equipment consists of two microscopes. The point of intersection of the axes coincides with the axis point of the object. E.F. (7.7)

The Lateral Chromatic Aberration of Apochromatic Microscope Systems. I. C. GARDNER & F. A. CASE. *Review of Scientific Instruments*, July 1931, pages 416-428.

Methods are described for the measurement of the lateral chromatic aberration and distortion of microscope objectives and eyepieces. Measurements have been made on 20 apochromatic microscope objectives of 4 different makes, and on 10 compensating eyepieces of 2 different makes. The results show that the compensating eyepieces in general do not entirely compensate the chromatic aberration of the objectives and that the complete microscope system is usually undercorrected. The bearing of this on the performance of the system in photomicrographic work by a three color process, and in the direct visual observation of objects is considered in detail. (7.7)

A New Metal Microscope. (Das neue Metall-mikroskop «Seibert-Metallus.) B. Blumenthal. *Die Giesserei*, Vol. 17, Aug. 22, 1930, pages 826-829.

The optical and mechanical requirements of a large microscope for metallurgical examinations are discussed and a new type of instrument embodying these features is described in detail. It is built by W. & W. Seibert, Wetzlar, Germany. Ha (7.7)

The World's Most Powerful Microscope. F. F. Lucas, *Journal of the Society of Motion Picture Engineers*, Vol. 16, April 1931, pages 445-456.

About 30 years ago Koehler, of the Zeiss works, developed a microscope using ultra violet light. It was practically forgotton till Bell Telephone Laboratories developed another recently. With this microscope it is possible to obtain brilliant images of metallurgical specimens magnified 5000 to 6000 diameters. The ordinary type microscope is limited to 1000 to 1500. Gives a full account of construction and operation of the microscope. RHP (7.7)

Limits of Microscopy. Beginning of the Molecular Optics. (Grenzen der Mikroskopie. Beginn der Molekularoptik.) F. Jentzsch. *Zeitschrift für Instrumentenkunde*, Vol. 51, Aug. 1931, pages 441-442.

Author aims at the development of an X-ray microscope with the object of extending the present measuring range (Glycerine immersion and ultra violet Cd line with $\lambda = 0.275\ \mu$, theoretically $\lambda = 0.107\ \mu$). The author prefers monochromatic X-rays, namely the Cu-line with $\lambda = 1.537$ A. U. or the Cr-line with $\lambda = 2.03$ A. U. The wave length of the X-rays utilized is consequently about one-tenth shorter than the wave length of the light used hitherto. EF (7.7)

The Distortion Error in Ocular-Microscopical Measurements with the Microscope. (Die Verzeichnungsfehler bei okular-mikroskopischen Messungen am Mikroskop.) W. Felgentraeger. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, March 1930, pages 189-192.

The greater part of the distortion is ascribed to the condensing lens and the application of a Ramsden ocular is recommended. E.F. (7.7)

Electromagnetic Rays (Except Visible Light) (7.8)

An X-Ray Powder Diffraction Apparatus of New Design. T. M. Hahn. *Review of Scientific Instruments*, Vol. 2, Oct. 1931, pages 626-631.

The instrument described here uses a beam of X-rays defined by a suitable slit system so that it has the form of a right circular cone. The beam of X-rays falls upon the powdered sample arranged in the axis of the cone, and the diffracted rays spread out and fall on a flat strip of film placed along the axis, recording on it clearly the position of all points of intersection of the refracted beam. The diffraction pattern is so clearly defined, as an illustration shows, that it can readily be evaluted. Ha (7.8)

A New X-Ray Spectrograph for Wave-Length Determinations in Air. S. Zeidenfeld. *Review of Scientific Instruments*, Vol. 2, March 1931, pages 153-163.

An instrument is described for X-ray spectrography for wave-lengths in the region of 0.5-2.0 A. It is the Bragg-type, having a rotating crystal and employing the photographic method of registration of the lines. The film holder is concentric to the axis of oscillation of the crystal, the radius is 15 cm. The arrangements and adjustments are described in detail. The width of the slot is about 0.01 cm., the obtainable accuracy 0.00035 cm., so that the greatest possible error in measuring separation between two lines is 0.0007 cm. Manipulation and performance are described, and 10 references cited. Ha (7.8)

Erythema Due to Ultraviolet Radiation. E. Q. Adams, B. T. Barnes & W. E. Forsythe. *Journal of the Optical Society of America*, Vol. 21, No. 4, April 1931, pages 207-222.

Recent work on the function of ultraviolet irradiation in the formation of the antirachitic vitamin D has awakened renewed interest in health-giving properties of radiations of shorter wave length than visible spectrum, and in photoerythema, the reddening of the skin produced by exposure to such radiations. While intensity of the radiation in this region is of first importance, and while no strict proportionality between erythema and benefit can be claimed, there are grounds for interest in the erythemal effect of the radiation: (1) no evidence that radiation of such wave lengths as do not under any circumstances produce erythema have any antirachitic effect; (2) desirable to avoid producing a painful degree of erythema, or sunburn, and (3) to avoid undue pigmentation, or tan, which diminishes the effectiveness of subsequent irradiation. Erythemal effectiveness of sources of mixed radiation are discussed. 9 curves of distribution, effectiveness, transmission, etc., and 4 tables are given and discussed. MFB (7.8)

Some Precision Measurements in the Soft X-Ray Region. M. Soderman. *London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, Vol. 10, Oct. 1930, pages 600-616.

Describes a laboratory apparatus used in the experiments. RHP (7.8)

A Precision X-Ray Spectrometer and the Wave Length of Mo, K 1. Arthur H. Compton. *Review of Scientific Instruments*, Vol. 2, July 1931, pages 365-376.

An x-ray spectrometer was designed with the first crystal mounted on an arm supported by the frame of the spectrometer, and with the second crystal mounted on the central table of the instrument, whose position is read from a precision circle. The ionization chamber (of 28 c.c. capacity, filled with krypton) is on an arm whose position is read by a second precision circle. The instrument was built by the Societe Genevoise de Physique. (7.8)

An Improved Quartz Mercury Vapor Lamp. Note. George Shannon Forbes and Lawrence Joseph Heidt. *Journal American Chemical Society*, Dec. 1931, pages 4349-4350.

The new model retains the advantages of earlier models and it eliminates cemented joints and objectionable capillaries formerly used to check mercury oscillations. MEH (7.8)

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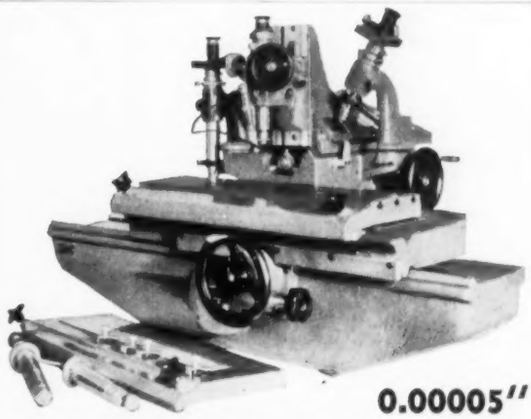

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Measurements on an X-Ray Apparatus of 400 KV. (Messungen an einer Roentgen-apparatur fuer 400 KV.) H. Hermann & R. Jaeger. *Zeitschrift fuer technische Physik*, Vol. 11, Nov. 1930, pages 461-465.

The present scope of X-ray tubes is extended from 200 KV. to 400 KV. The penetration power of these extremely hard X-rays is determined. The half-value layers in Cu and the reduction of intensities in Pb are investigated and the results compared with the absorption coefficients of the Radium-C-γ radiation. Wiring diagram corresponds to the circuit layout of Greinanch-Hull. E.F. (7.8)

Discharge-Tube for Production of a Continuous Spectrum of High Intensity in the Ultra-Violet Region. (Entladungsrohr zur Erzeugung eines lichtstarken kontinuierlichen Spektrums im Ultraviolett.) E. Lau, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Oct. 1930, pages 581-582.

Apparatus manufactured by the Karl Zeiss Co., Berlin-Steglitz, embodying the suggestions of Gehrke-Lau.

Obtaining Debeye-Scherrer Diagrams for Alloys Instable in the Atmosphere. (Ueber die Herstellung von Debeye-Scherrer Aufnahmen luftempfindlicher Legierungen.) E. Zintl, A. Harder & S. Neumann. *Zeitschrift fuer physikalische Chemie*, Sect. A, Vol. 154, April 1931, pages 92-96.

The authors developed a method for preparing oxidizing, hygroscopic and other materials instable at room temperature. The pulverizing for X-ray photograms (method Debeye-Scherrer-Hull) in vacuo is outlined, and the eventual annealing process in order to eliminate the effect of cold-working during the pulverization is described. The further treatment of the powder is fully discussed. E.F. (7.8)

A Spinthariscope for Measuring Radioactivity. H. A. Mangan & Herman Schlundt. *Preprint 59-30. The Electrochemical Society*, April 23-25, 1931, pages 315-321.

The spinthariscope is serviceable in rapidly establishing the fact of radioactivity in living persons; but in its present form it is quite inferior to the electroscope for accurate quantitative estimation of small quantities of radioactivity emanations. (7.8)

CHEMICAL ANALYSIS (8)

A method for Quantitative Analysis of Crystal Grains by X-Rays. (Eine Methode zur quantitative Kristallanalyse durch Roentgenstrahlen.) L. Grebe, *Zeitschrift fuer technische Physik*, Vol 11, Oct. 1930, pages 428-429.

A method is outlined in which conclusions are drawn from the intensities of Debeye lines of a crystalline grain mixture upon the amounts of the various components present. The method is checked on some ceramic materials. E.F. (8)

On Some Drawbacks of Quartz-Lamps Used for Fluorescence Analysis. (Ueber manche Nachteile der Anwendung der Quarzlampe fuer Fluorescenzanalyse.) J. Plotnikow, *Chemiker Zeitung*, Vol. 54, July 26, 1930, page 582.

Technical disadvantages and objections involved in the principle of the testing method are discussed. E.F. (8)

Potentiometer for Measuring Hydrogen-Ion Concentration. (Potentiometer zur Messung der Wasserstoffionen-Konzentration.) E. Bluhm. *Elektrotechnische Zeitschrift*. Vol. 52, Aug. 6, 1931, pages 1035-1036.

The alkalinity or acidity respectively of a solution is determined by its pH-value, that is its hydrogen-ion concentration. In a neutral solution this value is 7; in an alkaline solution >7, in an acidic <7. The concentration can be measured most conveniently by the electrical measurement of the voltage between two electrodes placed in the solution. The theoretical basis for the measurement is developed and a potentiometer described which permits reading to 1 millivolt. The range of the apparatus is from 0 to 1100 millivolts.

Novel Electrode Vessels for Rapid pH Measurements. (Neue Elektrodengefaesse fuer schnelle pH Messungen.) W. Kordatzki, *Chemische Fabrik*, Vol. 4, Jan. 21, 1930, pages 25-27.

The various features involved in this novelty are described and some results of measurements communicated. E.F. (8)

Titration of Lead by Means of a Thermionic Titrometer. R. W. Gelbach & K. G. Compton. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 398-399.

Diagrams are given of a three-tube and a two-tube circuit for determining the equivalence point in the titration of lead nitrate by potassium chromate. MEH (8)

Null-Point Method of Potentiometric Titration for Determining Acid or Alkali in Paper. Beverly L. Clarke & Leland A. Wooten. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 385-387.

A method of electrometric titration is described which involves the use of inexpensive apparatus and which is notable for its simple and rapid manipulation. When applied to the determination of paper acidity, this method is independent of the presence of dyes and makes unnecessary the application of a correction. The null-point system here described is shown to be useful for the accurate titration of certain weak acids and bases. This is effected by varying the concentration of potassium chloride in the calomel half-cell. MEH (8)

A Method for the Determination of Critical Temperatures and the Critical Temperature of Hydrogen Fluoride. P. A. Bond & Della A. Williams. *Journal American Chemical Society*, Jan. 1931, pages 34-37.

A new method for the determination of the critical temperature has been developed. It may be used for substances which attack glass, and for those like nitrogen dioxide, where a meniscus cannot be observed. MEH (8)

Glass Electrode Measurements by Means of a Galvanometer with Condenser Attachment.—Note. Malcolm Dole. *Journal American Chemical Society*, Feb. 1931, pages 620-622.

Results show that accuracy can be obtained also by the use of the condenser attachment. MEH (8)

The "Star Trail" Method for the Spectrographic Quantitative Determination of the Elements, Communication. A. C. Shead & G. Frederick Smith. *Journal American Chemical Society*, Dec. 1930, page 5295.

Work is in progress at the University of Illinois with special reference to the application of the "Star Trail" method to the quantitative analysis of the alkali metals. MEH (8)

Improved Bartell-Osterhof Cell. C. C. DeWitt. *Industrial and Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 424-425.

A new type of Bartell-Osterhof cell is described which eliminates to a large extent some of the mechanical defects of the old cell. It offers an opportunity to study the properties of liquid-liquid interfaces in contact with solids without the necessity of first packing wetted material in the cell. MEH (8)

The Measurement of the Conductance of Electrolytes. III. The Design of Cells. Grinnell Jones & Giles M. Bollinger. *Journal American Chemical Society*, Feb. 1931, pages 411-451.

By using an unshielded bridge carefully designed to avoid inductance and capacitance, the phase angle between the current and the voltage in conductance cells has been measured and made significant in the study of errors in conductance measurements and in the design of cells. The new cells here described can be used at frequencies and resistances so high as to make errors due to polarization negligible without introducing errors due to capacitative shunt so that results which seem to be reliable within 0.10% may be obtained with them. MEH (8)

The Theory of the Glass Electrode. Malcolm Dole. *Journal American Chemical Society*, Dec. 1931, pages 4260-4280.

The glass electrode is directly compared with the hydrogen electrode in solutions of lithium, sodium, potassium and barium salts at various concentrations and over the pH range 6 to 13. MEH (8)

Differential Potentiometric Titration. IV. [(a) An Adaptation of the Method to the Use of Hydrogen Electrodes. (b) A Test of Standards for Precise Acidimetry.] Duncan A. MacInnes & Irving A. Cowperthwaite. *Journal American Chemical Society*, Feb. 1931, pages 555-562.

The differential electrometric method for titration has been adapted to the use of hydrogen electrodes. The usefulness of the method has been shown by its application to precise acidimetry. MEH (8)

Method for the Determination of Nitrogen in Steel and Iron Alloys. (Verfahren zur Bestimmung des Stickstoffs in Stahl und Eisenlegierungen.) P. Klinger. *Archiv für Eisenhüttenwesen*, Vol. 5, July 1931, pages 29-33.

Report 82 of the Chemical Committee of the Verein deutscher Eisenhüttenleute. Includes discussion. The paper critically surveys the methods which have been used up to the present time for the determination of N in steel and its alloys and the causes and reasons that cause a failure of the common solution method are noted. A new method and apparatus which make it possible to determine the total amount of N in steel samples, independent of their solubility in acids have been developed and are described. GN (8)

Electrometric Measurement of Hydrogen Ion Concentration of Watery Solutions. (La mesure électrométrique de la concentration en ions hydrogène des solutions aqueuses.) A. Boutaric. *Revue Générale de l'Électricité*, Vol. 29, Feb. 14, 1931, pages 255-263.

The hydrogen ion concentration of a solution as expressed by the term pH defines exactly the basicity or acidity. This concentration can be measured by means of an electromotive force; the method with the use of potentiometers and a standard cell is described in detail and the use of electrodes of hydrogen, calomel and antimony for different solutions is discussed. 10 references are cited. Ha (8)

The Limits of Determination of Some Heavy Metals by Drop Reaction with Dithizone. (Die Erfassungsgrenzen für den Nachweis einiger Schwermetalle durch Tropfenreaktion mit Dithizon.) H. Fischer. *Wissenschaftliche Veröffentlichungen aus dem Siemens-Konzern*, Vol. 10, Mar. 1931, pages 99-107.

Dithizone (Diphenyl-Thiocarbazone) has proved to be quite remarkably well suited for the qualitative recognition of very small quantities of heavy metals which, for most purposes of the analytical practice, is entirely sufficient. This is due to vivid coloring and the ready solubility in organic solvents, though insoluble in water. The following sensitivities were found: for Zn, 1 : 2,000,000; Cu, 1 : 1,660,000; Ag, 1 : 1,000,000; Pb, 1 : 1,250,000; Co, 1 : 1,250,000 (all in neutral solutions); for others, the sensitivity is smaller but still very pronounced. The method is especially suitable for micro-chemical work. Ha (8)

Automatic Gas Tester. (Selbsttatiger Gasprüfer.) K. Brüggemann, *Elektrotechnische Zeitschrift*, Vol. 52, June 4, 1931, page 740; *Glückauf*, Vol. 66, page 340.

The Junkers Thermo-Technik, Berlin, has built an automatic instrument for the continuous determination of the amount of oxygen in gases. A definite volume of the gas to be tested is passed at 250° C. over a contact substance and the reduction in volume is measured, which is brought about by combustion of the hydrogen in the gas with the oxygen to water. The apparatus can also be used for the determination of waste gases. The construction is described in detail.

The Testing of Lubricating Oils. J. Poppleton. *Chemical Engineering & Mining Review*, Vol. 23, July 6, 1931, pages 396-398.

The usual tests are outlined for motor oils. Remarks on the tests are given to elucidate the purpose of the test.

A Method for the Determination of Molecular Weights in Liquid Ammonia. Note. Harold H. Strain & James H. C. Smith. *Journal American Chemical Society*, Dec. 1930, pages 5291-5293.

Apparatus and method are described for determining molecular weights in liquid ammonia. It is thought the method can be adapted also for micro procedure. Incidentally, ammonium chloride was found to be dimolecular in liquid ammonia. MEH (8)

The Electromotive Force of the Cell Zn (s), $ZnSO_4$ (m), $PbSO_4$ (s), Pb(s). (An Experimental Determination of the Temperature Coefficient of the Ion Size Parameter in the Theory of Debye and Hueckel.) Irving A. Cowperthwaite & Victor K. La Mer. *Journal American Chemical Society*, Dec. 1931, pages 4333-4348.

Electromotive force measurements precise to ± 0.05 mv. are reported for the above cell for 0.0005, 0.001, 0.002, 0.005, and 0.01 molal solutions and at temperatures 0°, 12.5°, 25°, 37.5° and 50°C.; also at 0.02 m. and 0.05 m. at 0°, 25° and 50°C. MEH (8)

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Gas-Analysis by Means of Catalytic Reaction and Measurement of Heat Content. (Gasanalyse mittels katalytischer Reaktion und Wärmetönungs messung.) H. Gruess. *Archiv für Technisches Messen*, 1931, section V723-2, page T25.

This method is of particular advantage where constituents of gases are to be determined which combine easily with other gases, for instance hydrogen or carbon monoxide with oxygen, as is the case in explosive mixtures in mines. Usually the temperature difference between an electrically heated wire in air and another one in the gas to be determined is measured. The methods and catalysers are described. Ha (8)

On a New Method of Checking the Catalytic Effect of the System Pa-H by Means of Resistance-Measurements. (Ueber eine neue Methode zur Verfolgung der katalytischen Wirkungen des Systems Palladium-Wasserstoff mit Hilfe von Widerstandsmessungen.) C. A. Knorr. *Zeitschrift für physikalische Chemie, Section A*, Vol. 157, Nov. 1931, pages 143-163.

A modified method of measuring the electrical resistance was employed for an investigation of the factors governing the hydrogen liberation out of palladium. EF(8)

Re-Determination of Thermal Dissociation Equilibria of Inorganic Compounds I. Determination of the Dissociation Equilibria of Calcium Carbonate by Means of the High Temperature Vacuum Balance. (Neubestimmung thermischer Dissoziationsgleichgewichte von anorganischen Verbindungen. I. Bestimmung der Dissoziationsgleichgewichte von Kalziumkarbonat mittels Hochtemperaturvakuumwage.) S. Tumaru, K. Stoni & M. Adati. *Zeitschrift für physikalische Chemie, Section A*, Vol. 157, Dec. 1931, pages 447-467.

The authors designed a high temperature vacuum balance which is fitted for determining the changes in weight of a solid body at elevated temperatures in vacuo or in an atmosphere of a gas of whatever nature and at any concentration. The great accuracy and the ease of operation of the new equipment is emphasized and experiments are carried out with the object of re-determining the dissociation equilibria of $CaCO_3$ between 614° and 891° C. Includes 6 illustrations. EF (8)

Gas Analysis by Measurement of Heat Conductivity. (Gasanalyse durch Messung der Wärmeleitfahigkeit.) Jos. Kroenert. *Archiv für Technisches Messen*, 1931, section V723-1, page T13.

This method consists in comparing the electrical resistance of a platinum wire in the gas to be determined with that in a gas of known conductivity. Principle and methods are described, literature references added. Ha (8)

A New Simple Equipment for the Exact Analysis of Gas Mixtures down to Quantities of 5 cc. (Eine neue, einfache Vorrichtung für die exakte Analyse von Gasgemischen in Mengen bis zu 5 c.cm. herab.) E. Ott & A. Schmidt. *Gas & Wasserfach*, Vol. 74, Nov. 28, 1931, pages 1107-1109.

An ingenious combination of the known combustion-absorption method of Ott and the "manometric" burette of Schmidt (See Gas & Wasserfach, Vol. 73, No. 48, Nov. 29, 1930, pages 1137-1144). The new set is furnished by the H. Goeckel Co., Berlin. The mode of operation and the way of evaluating measurements are given. EF (8)

The Quinhydrone Electrode. I. J. Livingston, R. Morgan, Olive M. Lammert & Margaret A. Campbell. *Journal American Chemical Society*, Feb. 1931, pages 454-469.

A study has been made of the reproducibility of the quinhydrone electrode in 0.1 N HCl under varying conditions and with a large number of electrodes of different sizes, ages and compositions, and some very useful conclusions have been drawn. MEH (8)

Quantitative Analysis by Monochromatic Transmission. Monroe Barnard & Paul McMichael. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 363-365.

A useful derivation from Lambert's law has been developed which enables one to calculate the decimal proportions of the components in a mixture from precise measurements of light-transmission factors. MEH (8)

A Magneto-Optic Method of Chemical Analysis. Fred Allison & Edgar J. Murphy. *Journal American Chemical Society*, Oct., 1930, pages 3796-3806.

This paper reports some results of a method which promises to be of value as a new means of chemical analysis. It also suggests a new angle of approach to certain aspects of the problem of ionization in liquids. The method is a refinement of one previously described by Allison in the investigations of the time lag differences of the Faraday effect behind the magnetic field in certain liquids as a function of the wave length of the light used. See Physical Review, 30, 66(1927); 31, 313, (1928); 35, 124(1930). MEH (8)

Chemical Micrurgy. A Method for Studying the Characteristics of Microscopic Quantities of Material. Robert N. Titus and Harry Leb. Gray. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 368-371.

Chemical micrurgy, which is chemical work on particles too small for an application of the usual technic, may be utilized in many investigations which are concerned with sources of contamination in the form of very small specks of material. Only general consideration of methods and microtools are discussed. MEH (8)

Automatic Gas Tester. (Selbsttaetiger Gaspruefer). K. Brueggemann. *Elektrotechnische Zeitschrift*, Vol. 52, June 4, 1931, page 740; Glueckauf, Vol. 66, page 340.

The Junkers Thermo-Technik, Berlin, has built an automatic instrument for the continuous determination of the amount of oxygen in gases. A definite volume of the gas to be tested is passed at 250°C. over a contact substance and that reduction in volume is measured which is brought about by combustion of the hydrogen in the gas with the oxygen to form water. The apparatus can also be used for the determination of waste gases. The construction is described in detail. Hh. (8)

The Vapor Pressure of Antimony Trioxide. W. B. Hincke. *Journal American Chemical Society*, Oct., 1930, pages 3869-3877.

A new type of static balanced tensimeter was used to determine the vapor pressure of liquid antimony trioxide between the temperatures 656°C. and 800°C. MEH (8)

The Cathode Ray Tube in X-Ray Spectroscopy and Quantitative Analysis. Gorton R. Fonda and George B. Collins. *Journal American Chemical Society*, Jan., 1931, pages 113-125.

The use of the cathode-ray tube is described for exciting x-radiation of samples placed before its window, and also the use of an ionization chamber and an amplifying system for recording the intensity. The application of the cathode-ray tube to the quantitative analysis of alloys is shown by both the ionization and the photographic methods. MEH (8)

The Hilger Steeloscope. *Automobile Engineer*, Vol. 21, Aug., 1931, page 282.

This instrument is a spectroscope. The specimens of alloy to be examined are used as the poles of an electric arc; the light is spread out by the steeloscope into a series of lines whose positions are distinctive of elements present in the specimen. The method of identifying the lines by a sliding eye piece is described. The instrument is capable of detecting Ni, Cr, Mo, Mn, Ti, W, Co, Cu, Sn, Cd and V. The percentages of the elements present can also be determined. Ha. (8)

A Micropenetrometer.—Its Application to the Testing of Fats. Egbert Freyer. *Industrial & Engineering Chemistry, Analytical Edition*. Oct. 15, 1930, pages 423-424.

Presented before the Division of Agricultural and Food Chemistry at the Atlanta, Ga., meeting of the American Chemical Society, April, 1930. The instrument is designed for determining the penetrability of large numbers of small experimental fat mixtures and of samples taken at various stages of hydrogenation. MEH (8)

A New Apparatus for Quick and Accurate Gas Analysis. (Ueber ein neues Orsatgeraet fuer schnelle und genaue Gasanalyse.) H. A. Bahr. *Gas & Wasserfach*, Vol. 73, May, 1930, pages 440-444.

Aims at the following improvements: Reduction of clearance space, increase in security of operation; application of safely working valve pipettes; application of a reliable combustion pipette, including an improved incandescent coil; utilization of the empty space in the Orsat case for an oxygen supply, protection of the objectionable rubber balls. E.F. (8)

An Automatic Zero-point Adjustment in Gas Burettes. (Eine selbstaendige Nullpunkteinstellung an Gasbueretten.) H. Drehschmidt. *Gas & Wasserfach*, Vol. 73, Dec. 27, 1930, pages 1241-1242.

Device consists of an overflow at the zero point. E.F. (8)

Modification of Winterstein's Micro-Respiration Apparatus. (Eine Abaenderung des Winterstein'sschen Mikrorespirationsapparates.) H. Bock. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, May, 1930, pages 322-329.

CO_2 and O_2 simultaneously determined. Description of the apparatus and some measurements. E.F. (8)

A New Gas Analyser. (Ein neuer Gasanalysenapparat.) F. Ritter. *Chemisch Technische Rundschau*, Vol. 46, Feb. 3, 1931, pages 59-60.

Glass stop cocks of Orsat apparatus are replaced by liquid valves and the combustion tube for H_2 and CH_4 includes an electric heating device and a cooling arrangement. The levelling bottle is replaced by a rubber balloon. E.F. (8)

A Novel Apparatus for Electrometric-potentiometric Analysis by Means of Electron Tubes. (Eine neue Apparatur zur elektrometrischen Massanalyse mittels Elektronenroehren.) E. Berl, H. Herbert & W. Wahlig. *Chemische Fabrik*, No. 45, Nov. 5, 1930, pages 445-446; No. 46, Nov. 12, 1930, pages 458-460.

An electron tube installation for potentiometric analysis as well as for pH determinations is described, distinguished by a simple wiring and general outlay and by low costs. E.F. (8)

Astronomy, Navigation, Aviation (9)

Maneuverability Investigation of the F6C-3 Airplane With Special Flight Instruments. C. H. Dearborn & H. W. Kirschbaum. *National Advisory Committee For Aeronautics, Synopsis of Report, No.* 369, 1931, 18 pages.

Air speed, angular velocity, linear acceleration, and position of the control surfaces were measured by instruments in the airplane during loops, push-downs, pull-outs from dives, pull-ups from level flight, barrel rolls, and spins. The coordinates of the flight paths were deduced from the data whenever possible, and were checked in some cases by the use of a camera obscura. The results are given in curves showing the variation of the measured quantities with respect to time, and maximum values are tabulated. (9)

A Method of Flight Measurement of Spins. Hartley A. Soule & Nathan F. Scudder. *National Advisory Committee for Aeronautics, Synopsis of Report No.* 377, 18 pages.

A method is described involving the use of recording turn meters and accelerometers and a sensitive altimeter, by means of which all of the physical quantities necessary for the complete determination of the flight path, motion, attitude, forces, and couples of a fully developed spin can be obtained in flight. Data are given for several spins of two training type airplanes which indicate that the accuracy of the results obtained with the method is satisfactory. (9)

Investigation of Damping Liquids for Aircraft Instruments —II. *National Advisory Committee for Aeronautics, Report No.* 398, 1931, page 3-19.

Data are presented on the kinematic viscosity, in the temperature range —50° to +30° C., of pure liquids and of solutions of animal oils, vegetable oils, mineral oils, glycerine, and ethylene glycol in various low freezing point solvents. It is shown that the thermal coefficient of kinematic viscosity as a function of the kinematic viscosity of the solutions of glycerine and ethylene glycol in alcohols is practically independent of the temperature and the chemical composition of the individual liquids. This is similarly true for the mineral oil group and, for a limited temperature interval, for the pure animal and vegetable oils. The efficiency of β-naphthol, hydroquinone, and diphenylamine to inhibit the change of viscosity of poppy-seed and linseed oils was also investigated. (9)

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Pressure
Bailey Meter Co.
Bristol Company
Brown Instrument Co.
Tagliabue Mfg. Co., C. J.

Pump
Bailey Meter Co.
Tagliabue Mfg. Co., C. J.

GLASS BLOWERS' GOGGLES
Burgess-Parr Co.

GREASE TESTING APPARATUS
Tagliabue Mfg. Co., C. J.

GROUND DETECTORS
Rubicon Company
Weston Elec. Inst. Corp.

GYPSUM TESTING INSTRUMENTS
Alfred Suter

HAND TALLEYS
Veeder-Root, Inc.

HARDNESS TESTERS
Baldwin-Southwark Corp.
Alfred Suter

HELIOSTATS
Gaertner Scientific Corp.

HIGH FREQUENCY APPARATUS
Rawson Elec. Inst. Co.
Rubicon Company
Weston Elec. Inst. Corp.

HIGH VOLTAGE

Fuses
Littelfuse Laboratories

Indicators
Weston Elec. Inst. Corp.

Measuring Devices
General Electric Co.
Weston Elec. Inst. Corp.

Testing Devices
General Electric Co.

HUB ODOMETERS
Veeder-Root, Inc.

HUMIDITY CONTROLLERS
Bristol Company
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

HUMIDITY RECORDERS

Wet & Dry Bulb Thermometers
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

HYDROGEN ION METERS

Indicating
Rubicon Company

HYDROMETERS
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

HYGROMETERS
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

ILLUMINOMETERS
Weston Elec. Inst. Corp.

IMPACT HARDNESS TESTER
Alfred Suter

IMPACT TESTING MACHINES
Alfred Suter

INDICATORS—See Gages

INDUCTANCES
General Radio Co.
Rubicon Company

INSTRUMENT CALIBRATION AND REPAIRS
Rawson Elec. Inst. Co.
Rubicon Company
Weston Elec. Inst. Corp.

INSTRUMENT FUSES
Littelfuse Laboratories

INSTRUMENT TRANSFORMERS
General Electric Co.
Weston Elec. Inst. Corp.

INSULATION TESTING EQUIPMENT
General Electric Co.
Rubicon Company

INTERFEROMETERS
Gaertner Scientific Corp.

KEYS AND SWITCHES
General Radio Co.
Rubicon Company

KEYSTROKE COUNTERS (for Typewriters, etc.)
Veeder-Root, Inc.

KILNBOY
Foxboro Co.

LABORATORY RHEOSTATS
Ward Leonard Elec. Co.

LACTOMETERS
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

LENGTH MEASURING MACHINES
R. Y. Ferner Co.
Gaertner Scientific Corp.

LEVELS

Centering
Bausch & Lomb Optical Co.
R. Y. Ferner Co.

Engineer's, Wye, Precision, Prism
R. Y. Ferner Co.
Taylor Instrument Companies

LOCOMOTIVE INDICATORS
Baldwin-Southwark Corp.

MAGNETIC RELAYS
Ward Leonard Elec. Co.

MAGNETOMETERS
Rubicon Company

MANOMETERS
Bailey Meter Co.
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Hays Corporation
Morey & Jones, Ltd.
Alfred Suter

MASTER CLOCKS
Gaertner Scientific Corp.

MEGOHMMETERS
Rubicon Company

MEGOHM VOLTMETERS
Weston Elec. Inst. Corp.

MELTING POINT APPARATUS
Burgess Parr Co.
Tagliabue Mfg. Co., C. J.

MICROAMMETERS
General Electric Co.
Rawson Electrical Instrument Co.
Weston Elec. Inst. Corp.

MICROFARADMETERS
General Radio Co.
Rubicon Company
Weston Elec. Inst. Corp.

MICROMETERS
R. Y. Ferner Co.
Gaertner Scientific Corp.

MICROSCOPES

Brineil
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.
Alfred Suter

Measuring
R. Y. Ferner Co.

Metallographic
Bausch & Lomb Optical Co.

Petrographical
Bausch & Lomb Optical Co.

Toolmakers'
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

MICROTOMES
Bausch & Lomb Optical Co.

MILLIAMMETERS
Bristol Company
General Electric Co.
General Radio Co.
Rawson Elec. Inst. Co.
Weston Elec. Inst. Corp.

MILLIVOLTMETERS
Bristol Company
Brown Instrument Co.
General Electric Co.
Rawson Electrical Inst. Co.
Taylor Inst. Companies
Weston Elec. Inst. Corp.

MOISTURE METERS
Tagliabue Mfg. Co., C. J.

MOTION RECORDERS

Mechanical
Baldwin-Southwark Corp.
Bristol Company
Foxboro Co.

MOTOR STARTERS
Ward Leonard Elec. Co.

MULTIMETERS
Rawson Elec. Inst. Co.

MULTIPLE PEN RECORDER
Baldwin-Southwark Corp.
Foxboro Co.

MULTIPLIERS
Weston Elec. Inst. Corp.

OHM METERS
General Radio Co.
Rawson Elec. Inst. Co.
Rubicon Company
Weston Elec. Inst. Corp.

OIL TESTING APPARATUS
General Electric Co.
Tagliabue Mfg. Co., C. J.
Taylor Inst. Companies

OPERATION RECORDERS

Electrical
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.

ORIFICE METERS

Indicating
Bailey Meter Co.
Defender Automatic Regulator Co.
Morey & Jones, Ltd.

Indicating & Recording
Bailey Meter Co.
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.

ORSAT APPARATUS
Hays Corporation

OSCILLATORS
Weston Elec. Inst. Corp.

OSCILLOGRAPHS
Baldwin-Southwark Corp.
General Electric Co.
General Radio Co.

OXYGEN RECORDERS
Hays Corporation
Tagliabue Mfg. Co., C. J.

PANTOGRAPHS
Gaertner Scientific Corp.

PERISCOPES
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

PERMEAMETERS
Rubicon Company

PHOTO-ELECTRIC CELLS
General Electric Co.
Weston Elec. Inst. Corp.

PHOTO-ELECTRIC COLOR ANALYZERS
General Electric Co.

PHOTO-ELECTRIC COLOR COMPARATORS
General Electric Co.

PHOTOMETERS
Gaertner Scientific Corp.
Bausch & Lomb Optical Co.

PHOTO-MICROGRAPHIC EQUIP.
Bausch & Lomb Optical Co.

PHYSICAL TESTING MACHINES
Baldwin-Southwark Corp.
Alfred Suter

PITOT TUBE METER
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.

PLANIMETERS

Automatic Flow Record
Brown Instrument Co.
Foxboro Company

Linear
Brown Inst. Co.
Baldwin-Southwark Corp.

Radial
Bailey Meter Co.
Bristol Company
Foxboro Co.

Square Root
Foxboro Company

POLARISCOPES
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

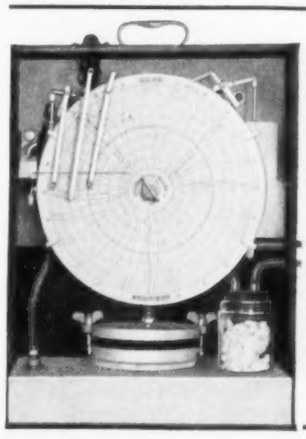
POSITION RECORDERS
Bristol Company
Foxboro Co.
Tagliabue Mfg. Co., C. J.

POTENTIOMETERS—Indicating
Brown Instrument Co.
General Electric Co.
Rubicon Company

Recording & Controlling
Brown Instrument Co.

Standard Cell Comparing
Eppley Laboratory, Inc.

Feussner Type
Eppley Laboratory, Inc.



DEFENDER : PORTABLE
Combustion Efficiency
RECORDER

A small Portable Instrument to record on 10" chart percent CO_2, Flue Gas Temperature and the Furnace Draft, on any make or type of High or Low pressure Boiler, with any type of Furnace, burning any type of Fuel.

This record allows you to determine by Flue Gas Analysis method the Combined Boiler and Furnace Efficiency; the pounds of air per pound of fuel used and the total and preventable loss of Fuel taking place, and we furnish the printed data tables to make these determinations by.

DEFENDER AUTOMATIC REGULATOR COMPANY
St. Louis, Mo.

Present Status of Aircraft Instruments. *National Advisory Committee for Aeronautics, Report No. 371.* By Subcommittee on Air Navigation Instruments, N.A.C.A. 1931, 26 pages.

The present state of development of aircraft instruments is summarized, with emphasis on the present trend of development. The report includes sections on speed instruments, altitude instruments, navigation instruments, power plant instruments, oxygen instruments, instruments for aerial photography, fog flying instruments, general problems, and summary of instrument and research problems. The relative utility of the various types of instruments available for any one definite purpose is discussed in so far as reliable data are available. The research problems considered include both those of special interest to instrument engineers and to operators of aircraft. 46 references are given to the more recent fundamental papers on the subject. (9)

The Bergedorf Plate-Meters for the "Zone Enterprise" of the Astronomische Gesellschaft. (Die Bergedorfer Plattenmesser fuer das Zonenunternehmen der Astronomischen Gesellschaft.) R. Schorr & F. Dolberg, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Aug. 1930, pages 445-460.

The Astronomical Society intends to re-determine the positions of all stars located between the north-pole and -5° declination. The investigation will be carried out during the coming years by the photographic method fully outlined in the paper. E.F. (9)

On the Development of the Astronomical Instruments of the Zeiss Company, Jena. (Ueber die Entwicklung der astronomischen Instrumente im Zeisswerke-Jena.) F. Meyer. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Jan. 1930, pages 58-99.

The abundantly illustrated paper traces the historical development of the astronomical equipment brought on the market by the Carl Zeiss Co. E.F. (9)

Meridian Determination with the Sun-Compass. (Meridianbestimmung mit dem Sonnenkompass.) V. Theimer, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Aug., 1930, pages 477-479.

Errors in reading of the common needle due to local disturbances of earth magnetism are responsible for the increased utilization of the sun compass the construction and application of which is given. E.F. (9)

Description of a Bifilar, Suspended, Meter for Electrically Registering on Ship's Deck the Velocity of Currents. (Beschreibung eines bifilar aufgehängten, an Bordelektrisch registrierenden Strommessers.) H. Rauschelbach, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Oct. 1930, pages 594-595.

Velocity of the water current is measured by a small propeller, the revolutions of which are registered on board of the ship. E.F. (9)

Investigations on the Accuracy of Wireless Longitudinal Determinations with Special Regard to the Zenith Refraction. (Untersuchung ueber die Genauigkeit von Laengenbestimmungen auf funkentelegraphischen Wege unter besonderer Beruecksichtigung der Zenithrefraktion.) H. Mahnkopf. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Sept. 1930, pages 558-559.

Paper at the Fourth Meeting of the Baltic Geodetic Committee, Helsingfors. E.F. (9)

Aircraft Instruments. *Abstracts from the National Advisory Committee for Aeronautics Report, No. 371. The Instrument World*, Vol. 4, Oct. 1931, pages 111-112, 116.

Relative and true speed measuring instruments, altitude meters, rate-of-climb indicators and thermometers for the special use in aircraft are described and the best location for them discussed. Ha (9)

Commercial Flight-Testing. E. W. Rounds. *Society Automotive Engineers Journal*, Vol. 28, May, 1931, pages 511-523.

The author gives an outline of methods for determining items of airplane performance which are valuable to the manufacturer for advertising purposes and can be reduced to a basis permitting comparison with other data obtained in a similar manner. He proposes that these data be approved by Aeronautical Chamber of Commerce. Besides tests for the airplane as a whole the following instruments, appropriate for the tests in question, must be used in obtaining the performance data: air speed indicator, air speed recorder, altimeter, barograph, tachometer, strut thermometer, or equivalent, stop watch. Schedules of test, calibration, and derivation of characteristics are explained in detail. Ha (9)

GEODESY, GEOLOGY (10)

Photogrammetry in its Geodetical and Engineering Importance. (Die Photogrammetrie in ihrer geodätischen und ingenieur-technischen Bedeutung.) G. Schewior. *Allgemeine Vermessungsnachrichten*, Vol. 43, Dec. 16, 1931, pages 785-790.

The flexibility of application of photogrammetric pictures is pointed out; it can be useful for the forestry, laying out of rural settlements, making relief maps, etc. Ha (10)

Methods Used in Electrical Prospecting. Jos. I. Heller. *Electronics*, Vol. 3, Nov. 1931, pages 184-185, 214.

The application of electrical and electronic principles in the field of geophysics, particularly for the detection of ore deposits, is explained and illustrated by the 4 methods used for this purpose: (1) the equipotential method, (2) the potential ratio method, (3) the electromagnetic ratio method, (4) the electromagnetic compensation method. All 4 methods determine the current path through the earth by the measurements of potentials. The metallic ore of good conductivity disturbs the regular distribution and thus permits recognizing the location of the veins. Ha (10)

A Tilt-Compensation Seismometer. H. E. McComb. *Bulletin of the Seismological Society of America*, March 1931, pages 25-27.

A tilt-compensation seismograph utilizing viscous coupling between the steady mass and the multiplying lever has been developed. The method of application of the viscous coupling differs from that described by Romberg, but the principle of continuous compensation for static tilt is practically the same. (10)

Geophysical Methods and Instruments for Locating Mineral Deposits. R. Leonhardt. *Engineering Progress*, Vol. [illegible], April 1931, pages 88-92.

Prospecting is done nowadays not solely on geological findings but is replaced by geophysical methods resting on a purely scientific basis. Four methods are used for locating hidden mineral deposits by the remote action of physical influences exerted by the different masses forming the earth's crust: The gravimetric method by Eötvös is represented by the torsion balance, which determines the changes in gravitational force due to the formation of different material layers in the earth. The magnetic method works by ascertaining the path of the magnetic lines of force in the earth from the north pole to the south pole. The seismic method (by Mintrop) is based upon calculation of the rate of travel of disturbance waves generated by artificial means, and the fact that the propagation of these waves will be faster or slower according to the varying elasticity of the intervening masses. Electrical methods measure the natural currents generated in the vicinity of deposits such as sulphide ores, or determine the conductivity for artificial currents of the strata to be examined, or measure the disturbances caused in the normal magnetic field of the earth by the introduction of artificial current; or, finally, an artificial field is formed by induction. The various methods are treated more in detail and the instruments used with them described. Ha (10)

Prospecting for Oil by Electrical Methods. (Prospektieren auf Oel mit elektrischen Methoden.) K. Sundberg. *Petroleum*, Vol. 26, March 5, 1930, pages 317-324.

After briefly considering former methods in the introduction, the author fully deals with the principles of electric prospecting and gives some practical results. E.F. (10)

INSTRUMENT DESIGN AND CONSTRUCTION (11)

Precision Lever Gages and Lever Links. (Präzisionsfühlhebel und Hebelgelenke.) G. Berndt & G. Bochmann, *Feinmechanik und Präzision*, Vol. 39, May 1, 1931, pages 30-36; Aug. 1, pages 103-109; Nov. 1, pages 173-179.

The kinematics of lever gages in their different forms, optimeter, minimeter, microtast, with direct reading or mirror reading, with edge bearings, ball bearings, crank movements, are discussed and theoretically investigated. The quality of such an instrument or tool depends on the sensitivity, accuracy of reading, accuracy of manufacture. The errors and correction curves are determined. Ha (11)

Torque in Instruments. J. L. Ferns. *The Electrical Review*, Vol. 109, July 31, page 167.

The theory of determining the characteristics of moving-iron and dynamometer type instruments is explained and an equation developed to calculate the torque exerted by the system in dyne-centimetres. Ha (11)

Fine-Mechanical Construction Problems and Their Economical Solution. (Konstruktionsaufgaben der feinmechanischen Technik und ihre wirtschaftliche Lösung.) Werner Kniehahn. *Feinmechanik u. Präzision*, Vol. 39, April 1, 1931, pages 2-7.

Just as standardization has been effected for the auxiliary parts and elements in the construction of big machinery, the author emphasizes the importance of a systematic development of all elements used in fine-mechanics. He shows by examples how such a development could best be started, f.i. for rigid joints, disconnecting joints, movable joints, etc., and illustrates numerous examples of electrical and mechanical apparatus. Ha (11)

Instrument Moving-Coil Supports. *Electrical Review*, Dec. 11, 1931, page 880.

Contains a statement from Chas. E. Foster disputing the claim made in *Electrical Review*, Aug. 21, 1931, that use of magnetic supports for the moving coil of an electrical instrument provides a greater degree of resiliency than that obtainable with springs, in so far as comparison is involved with the "Resilia" spring-mounting system employed by the Foster Instrument Co. In the "Resilia" design, as in the magnetic-suspension system, jewels are jointed together by a light staff so that separation of pivot and jewel is impossible. MS (11)

Investigations into the Function of Pivoting Elements of Electric Meters. (Recherches sur le fonctionnement des organes de pivotage des compteurs d'électricité.) G. Grunerd. *Revue Générale de l'Electricité*, Vol. 29, May 30, 1931, pages 869-874.

The behavior of bearings and pivots in meters was tested with regard to pressure and wear with and without lubrication, with sockets of steel and of sapphire. The testing arrangements are described. The resistance to wear of synthetic stones for the pivot compares favorably with that of steel pivots in a diamond socket. They outlive the meter. Artificial rubies or sapphires as points for the axes of the moving elements are therefore recommended in place of steel points. Ha (11)

The New Brown Potentiometer Recorder. T. R. Harrison. *Review of Scientific Instruments*, Vol. 2, Oct. 1931, pages 618-625.

This recorder is an instrument that adjusts a slide-wire contact to an appropriate position along a slide wire to represent the quantity being measured; it can also be used as a self-balancing Wheatstone bridge, in resistance thermometry, etc. There is a cold-junction temperature equalization and a humidity chart compensator. Ha (11)

Heavy Telescope Design. Henry Simon. *Product Engineering*, Vol. 2, July 1931, pages 290-294.

The mechanical problems offered in the construction of large heavy telescopes are discussed and the two principal types, reflectors and refractors, and their principal methods of mounting described in detail. The balancing of weights, deflection of shafts for counterweights, testing methods for proper alignment, the worm gears used for the movements, are all described and the arrangements shown to prevent later development of the slightest play or resistance in the gears. As all movements are comparatively slow and the loads light, the question of wear does not enter into the design; the vital point of design is ultra-precision. Ha. (11)

POWER FACTOR METERS
General Electric Co.
Jewell Elec. Inst. Co.
Weston Elec. Inst. Corp.

PRESSURE RECORDERS
Bailey Meter Co.
Bristol Co.
Brown Instrument Co.
Defender Automatic Regulator Co
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

PROCESS TIMING AND SIGNALING INSTRUMENTS
Bristol Company
Foxboro Co.
Tagliabue Mfg. Co., C. J.

PROJECTION LANTERNS
Bausch & Lomb Optical Co.

PROTRACTOR
Optical
Bausch & Lomb Optical Co.

PSYCHROMETER
Recording
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Inst. Companies
Sling
Taylor Inst. Companies

PYRHELIOMETERS—Weather Bureau Type
Eppley Laboratory, Inc.

PYROMETERS
Optical
Pyrometer Instrument Co.
Radiation
Indicating
Brown Instrument Co.
Pyrometer Instrument Co.
Taylor Instrument Companies
Recording
Brown Instrument Co.
Pyrometer Instrument Co.
Taylor Instrument Companies
Thermo-electric
Immersion
Bristol Company
Brown Instrument Co.
Foxboro Co.
Pyrometer Instrument Co.
Taylor Instrument Companies
Indicating
Bristol Company
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Taylor Instrument Companies
Recording and Controlling
Bristol Company
Brown Instrument Co.
Foxboro Co.
Taylor Instrument Companies
Surface Contact
Bristol Company
Brown Instrument Co.
Pyrometer Instrument Co.
Taylor Instrument Companies

RADIATION TUBES
Pyrometer Instrument Co.

RADIO FREQUENCY OSCILLATORS
General Radio Company

RADIO SET ANALYZERS
General Radio Company
Weston Elec. Inst. Corp.

RADIO TEST PANEL
Rubicon Company
Weston Elec. Inst. Corp.

RADIO TUBE CHECKERS
General Radio Company
Weston Elec. Inst. Corp.

REFRACTOMETERS
Bausch & Lomb Optical Co.

REGULATORS—See Controls

RELAYS
General Electric Co.
General Radio Co.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.
Light Sensitive
Burgess Laboratories, Inc., C. F.
Vacuum Contact
Burgess Laboratories, Inc., C. F.
Vacuum Tube
Burgess Laboratories, Inc., C. F.

REMOTE METERING EQUIPMENT
Bailey Meter Co.
Bristol Company
Brown Instrument Co.
General Electric Co.

RESISTANCE—Electrical
General Radio Co.
Rubicon Company
Ward Leonard Elec. Co.

RESISTANCE COILS
Ward Leonard Elec. Co.

RESISTOR UNITS
Ward Leonard Elec. Co.

"REV-METERS"
Veeder-Root, Inc.

RHEOSTATS
General Radio Company
Rubicon Company
Ward Leonard Elec. Co.

SACCHARIMETERS
Bausch & Lomb Optical Co.
Taylor Inst. Companies

SACCHAROMETERS
Tagliabue Mfg. Co., C. J.

SALINITY INDICATORS
Rubicon Company

SCALES
Gaertner Scientific Corp.
Alfred Suter

SEISMOGRAPHS
R. Y. Ferner Co.

SHUNT METERS
Bristol Co.

SHUNTS
Rawson Elec. Inst. Co.
Rubicon Company
Weston Elec. Inst. Corp.

SIGNALING DEVICES—Automatic
Brown Instrument Co.
Foxboro Co.
Rubicon Company

SPECIAL COILS
Ward Leonard Elec. Co.

SPECIAL ELECTRICAL INSTRUMENTS
Bristol Co.
Brown Instrument Co.
General Radio Co.
Rawson Elec. Inst. Co.
Rubicon Company
Weston Elec. Inst. Corp.

SPECIAL INSTRUMENTS
Burgess Laboratories, Inc., C. F.

SPECIFIC GRAVITY APPARATUS—Gas
Hays Corporation

SPECTROGRAPHS
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.

SPECTROPHOTOMETERS
Bausch & Lomb Optical Co.
Gaertner Scientific Corp.

SPECTROSCOPES
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.

SPEED COUNTERS
Veeder-Root, Inc.

SPEED INDICATORS
See Tachometers

SPEED RECORDERS
Bristol Company
Brown Instrument Co.

SPEED REGULATORS
Ward Leonard Elec. Co.

STANDARD CELLS
Eppley Laboratory, Inc.
Weston Elec. Inst. Corp.

STOP WATCHES
R. Y. Ferner Co.

STRAIN GAGES
Baldwin Southwark Corp.
Alfred Suter

SULPHUR DETERMINATION APPARATUS
Burgess Laboratories, Inc., C. F.
Tagliabue Mfg. Co., C. J.

SULPHUR DIOXIDE METERS
Hays Corporation
Tagliabue Mfg. Co., C. J.

SUNSHINE RECORDERS
Taylor Instrument Companies

SURGE INDICATORS AND RECORDERS
General Electric Co.

SYNCHRONIZING FORKS—Electrical
General Radio Co.

TACHOGRAPH
Baldwin-Southwark Corp.

TACHOMETERS
Bailey Meter Co.
Bristol Company
Brown Instrument Co.
Foxboro Co.
Veeder-Root, Inc.
Weston Elec. Inst. Corp.

TACHOSCOPES
Brown Instrument Co.

TELEMETER
Baldwin-Southwark Corp.

TELESCOPES
Bausch & Lomb Optical Co.
R. Y. Ferner Co.
Gaertner Scientific Corp.

TENSILE TESTERS FOR PAPER, WIRE, SHEETS, ETC.
Alfred Suter

TENSOMETER (Huggenberger)
Baldwin-Southwark Corp.

TESTING MACHINES
Fatigue
Baldwin-Southwark Corp.
Alfred Suter
Impact
Baldwin-Southwark Corp.
Alfred Suter
Hardness
Baldwin-Southwark Corp.
Alfred Suter
Portable—Hardness
Alfred Suter
Portable—Tensile—Compression
Baldwin-Southwark Corp.
Alfred Suter
Sheet Metal
Alfred Suter
Baldwin-Southwark Corp.
Oil & Bearing
Baldwin-Southwark Corp.
Universal
Baldwin-Southwark Corp.
A. Suter

TEXTILE TESTING INSTRUMENTS
A. Suter

THERMIONIC RECTIFIERS
General Electric Co.

THERMO-JUNCTIONS (Electric)
General Radio Co.
Rawson Electrical Inst. Co.

THERMOPILE—Coblenta Type
Eppley Laboratory, Inc.

THERMOMETERS
Gas Filled
Bailey Meter Co.
Bristol Company
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Company
Tagliabue Mfg. Co., C. J.
Taylor Inst. Companies
Mechanical
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Mercurial
Bristol Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies
Resistance
Brown Instrument Co.
Foxboro Co.
Vapor-Tension
Bristol Company
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Inst. Companies
Wet & Dry Bulb
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

THERMOSTATS
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

TIME INDICATORS
Baldwin-Southwark Corp.

TIME METERS
General Electric Co.

TIME OPERATION RECORDERS
Bristol Company
Foxboro Co.
Tagliabue Mfg. Co., C. J.

TIME RECORDERS
Bristol Company
Brown Instrument Co.
Gaertner Scientific Corp.
Foxboro Co.
Tagliabue Mfg. Co., C. J.

TIME SWITCHES
General Electric Co.

TIMERS
Rawson Elec. Inst. Co.
Rubicon Company

TORSIOGRAPH
Baldwin-Southwark Corp.

TORSION MACHINES
Alfred Suter

TRANSFORMATION POINT RECORDERS
Brown Instrument Co.

TRANSFORMERS (Instrument)
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Electrical Inst. Corp.

TRANSITS
Engineer's, Surveyors, Mine
Gaertner Scientific Corp.
Pocket
Taylor Instrument Companies

TUNING FORKS—Electrically Driven
General Radio Co.
Gaertner Scientific Corp.
Rubicon Company

TURBIDIMETERS
Burgess-Parr Co.

U-TUBE MANOMETERS
Bailey Meter Co.
Defender Automatic Regulator Co.
Hays Corporation
Morey & Jones, Ltd.

VACUUM RECORDERS
Bailey Meter Co.
Bristol Company
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

VACUUM TUBE BRIDGES
General Radio Company

VACUUM TUBE RELAYS
Burgess Laboratories, Inc., C. F.

VACUUM TUBE VOLTMETERS
Rawson Elec. Inst. Co.

VALVES
Automatic Shut Off
Bristol Company
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Company
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.
Balanced
Bailey Meter Co.
Brown Instrument Co.
Defender Automatic Regulator Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Diaphragm
Bristol Company
Defender Automatic Regulator Co.
Foxboro Company
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies
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On the Construction of Well-Insulated Radio-Active Collectors for Atmospheric Electrical Measurements. (Ueber den Bau gut isolierter, radioaktiver Kollektoren fuer luftelektrische Messungen.) W. GRUNDMANN, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Dec. 1930, pages 695-696.

Treats of a collector designed by the author and used in the Meteorological Observatory Breslau-Krietern. E.F. (11)

Reduced Scale Telescope for Measuring Angles of Deflection. (Verkuerztes Skalenfernrohr zur Messung von Winkelausschlägen.) J. KOENIGSBERGER, *Zeitschrift fuer Instrumentenkunde*, Vol. 50, June 1930, pages 374-375.

Reading with the classical Poggendorff arrangement requires 1m. scale in case of 3m. distance. 7 cm. length is sufficient in the author's improved method. E.F. (11)

New Possibilities in Precision Clock Manufacturing (Neue Moeglichkeiten des Praezisionsuhrenbaus.) H. GEFFKEN, H. RICHTER, & H. BOCK. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Sept. 1930, pages 559-560.

Reviews the investigations of Schieferstein, Schort & Schulze, Siadbei, Hensel, Madison (Western Electric), Karolus & Hensel, and Lejay. E.F. (11)

Flexible Optical Instruments. (Biegsame optische Instrumente.) H. LAMM. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Oct. 1930, pages 581-582.

Reports on investigations carried out with the object of increasing the facilities for surgical purposes. E.F. (11)

GENERAL AND MISCELLANEOUS (12)

General (12.1)

Apparatus for Statistical Recording. (Geräte für statistische Aufzeichnungen.) PAUL THOMAS, *Siemens-Zeitschrift*, Vol. 11, April 1931, pages 223-227; May, page 243.

Mathematical statistics are nowadays applied to a very great extent for biometric, economic and technical purposes in the evaluation of properties of quantity products, etc.; for instance, tests made with them to show their satisfactory quality. Two methods are in use, the "frequency curve" and its integral form, the "frequency-sum curve." The nature of the two is explained and illustrated by an example. The practical determination of a distribution of a frequency can be effected by instruments which mostly count the measured values by the change of electrical resistances which are connected to a battery. The voltage drop measured on these resistances or groups of resistances corresponds to the relative frequency or the sum of frequencies. The operating mechanism of such an instrument is described in detail. Ha (12.1)

A New Apparatus for Shock-Proof Mounting of Instruments. (Ein neuer Apparat zum erschuetterungsfreien Aufstellen von Messinstrumenten.) R. MUELLER, *Zeitschrift für Instrumentenkunde*, Vol. 51, Feb. 1931, pages 95-97.

Apparatus developed in the Phys. Inst. of the University of Berlin under direction of Prof. Nernst. The following advantages are claimed: The instrument can be mounted in a few minutes, clamped in any position, can be carried by a single person due to its low weight, requires small space, so that mounting under a case can be easily accomplished. It has no pre-requisites in regard to symmetry, has absence of iron, and simple mode of operation. EF (12.1)

Vacuum Tubes and Their Applications. W. C. WHITE. *Electrical Engineering*, Vol. 50, June 1931, pages 404-405.

Vacuum tubes are classed according to: (1) the number of electrodes; (2) the content of the bulb which may be high vacuum, gas, or vapor; and (3) the nature of the fundamental electrode, the cathode, which may be thermionic, photoelectric, mercury-pool, or cold. A high-vacuum tube affords: (1) independence of frequency; (2) continuous control, voltage control, or rectification. The thyratron tube has greatly decreased the amount of power required to heat the cathode, and a marked reduction in the large voltage drop characteristic of the high-vacuum tube. The thyratron tube is, at present, limited to a few thousand cycles per second, and it cannot control direct current as does the high-vacuum tube. WHB (12.1)

Rays of Slow Electrons and Their Technical Applications. (Strahlen langsamer Elektronen und ihre technische Anwendung.) E. BRUECHE. *Forschung und Technik*. Published by Julius Springer, Berlin, 1930, pages 23-46.

A short description of the electric, magnetic, as well as current and energy properties of the electron methods of producing well defined, slow moving electron-rays is given. It is possible by changing the gas concentration and by suitably shaping the anode to generate "thread-rays" of 1 mm. diameter; these rays are very well adapted for the measurement of magnetic fields, earth field, field components, so that a practically useful airplane compass of this kind has already been developed. Further, this ray can be used for finding current-carrying cables, for increasing currents, high frequency meters, product and quotient measurements. Some practical electron-ray tubes are described and the principles of all measurements named above fully explained. Ha (12.1)

The Accuracy of Planimetering of Indicator Diagrams. (Die Genauigkeit der Planimetrierung von Indikatordiagrammen.) P. W. ERNEST. *Automobiltechnische Zeitschrift*, Vol. 34, June 20, 1931, pages 399-400.

It is shown that an indicator for taking diagrams of high-speed engines records the pressures in the cylinder the truer the greater the number of natural vibrations of the recording device per stroke of the engine. Also that, for a great scale and a great stroke of the indicator drum, the diagram should be as small as possible. The possible errors were experimentally investigated, the personal factor is the most important in the evaluation of the diagrams. 5 references are cited. Ha (12.1)

The Installation of Boiler Instruments. *Engineering & Boiler House Review*, Vol. 45, Oct. 1931, pages 262-266.

6 different outlays of boiler house installations are described in detail, together with the choice of instruments, their arrangements and prices for the installations. Ha (12.1)

Miscellaneous (12.2)

Vibration-Originator and-Meter Geodyn for the Determination of the Elastic Constants of the Ground, Especially of the Foundation Number. (Schwingungserreger und-messer Geodyn zur Bestimmung der elastischen Konstanten des Erdreichs, insbesondere der Bethungsziffer.) P. MUELLER. *Zeitschrift des Verein deutscher Ingenieure*, Vol. 75, Jan. 17, 1931, pages 81-82.

For the erection of buildings the knowledge of the elastic conditions of the soil is absolutely necessary. The foundation number is that measure which indicates how high the unit of area of the soil has to be loaded in order to be elastically compressed by the same unit of length. An instrument for the direct measurement of the foundation number is described. It consists of two concentric masses around a vertical axis which are coupled together by a measuring spring. The inner lighter mass is rigidly connected to the ground and is excited by vertical impulses and brought to resonance with the natural oscillation of the ground. The bigger outer mass remains practically at rest. The rather complicated theory is briefly explained; the heavy mass carries a recording instrument on which speed of driving motor and frequency of impulses are recorded, from which the elasticity can be computed. Ha (12.2)

Observations on the Testing of Lubricants. E. WOOLER. *S.A.E. Journal*, Vol. 28, Jan. 1931, pages 53-55. With discussion.

The Timken Roller Bearing Company developed their own testing machines for testing lubricants; they comprise a machine for determining the load carrying capacity of lubricants for spiral-level and hypoid gears, a machine for recording surface roughness, one for testing abrasive properties. Describe construction and give the test results. The discussion brings out that a great deal of research in this field is still to be done. Ha (12.2)

Testing Equipment for Refractory Materials. L. LITINSKI. *The Ceramic Age*, Vol. 16, Dec. 1930, pages 332-335.

This article describes a few accessories to prepare test pieces for a refractories testing laboratory, as saws, boring machines, equipment for grinding thin sections of bricks, etc., and some pyrometers for temperature measurements. Ha (12.2)

The Measurement of Dust-Like Solid Particles. Messen staubartiger Festteilchen.) R. MELDAU. *Zeitschrift Verein Deutscher Ingenieure*, Vol. 75, Nov. 28, 1931, page 1467.

The peculiar conditions of fine powders and the difficulties of their measurement are discussed. A few instruments exhibited at the International Materials Testing Congress in Zurich, Sept. 1931, are described; they are based on optical methods, or on measuring the content of dust in air and gases, or suspension methods. Ha (12.2)

Methods for the Testing of Air-Filters. (Verfahren zur Untersuchung von Luftsfiltern.) W. SELL. *Zeitschrift Verein deutscher Ingenieure*, Vol. 75, March 7, 1931, pages 295-296.

This method uses a very finely powdered, water soluble, aniline dye which is put into the air going into the filter in exactly determined quantities; behind the filter the air passes a special filter where that part of dust which was not retained by the air-filter is completely absorbed. This filter is then washed and from the coloring of the water the amount of dye dust can be determined by comparison with standard solutions. It is claimed this method will give an accuracy of 0.5%, while the usual gravimetric tests permit hardly better than 10%. An example is given. 9 references. Ha (12.2)

Investigations of the Air Resistance in Tunnels. (Untersuchungen über den Luftwiderstand an Eisenbahnzügen in Tunnels.) K. SUTTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 75, March 21, 1931, page 359.

A new formula for the air resistance of trains in tunnels is developed which satisfies the greater velocities, profiles, and lengths of modern trains. Numerical values are given; tests showed a good agreement with the formula. Ha (12.2)

Testing of Goggles by the Ball-drop Method. (Prüfung der Augenschutzgläser nach dem Kugelfall-Verfahren.) G. ROSI. *Glasstechnische Berichte*, Vol. 9, July 1931, pages 389-390.

The tests according to the German rules are made with a ball of 16g. falling from a height of 1m. on the glass. The glass must not break. A sample which is broken must show round cracks or pieces with round edges. A comparison between American and German rules shows no agreement. Ha (12.2)

A Few New Forms of Recording and Observation Methods of Angular Deflections in Explosion Motors. (Sur quelques formes nouvelles de la méthode d'enregistrement et d'observation des écarts angulaires des machines à explosion.) ANDRÉ BLONDEL. *Revue Générale de l'Electricité*, Vol. 30, 1931, Sept. 26, pages 498-500; Comptes Rendus, Vol. 193, Aug. 3, 1931, pages 278-282.

Described arrangements of stroboscopic disks with neon tubes which replace the spark gap formerly used, and which give a much more distinct picture of the torsional deflection. Ha (12.2)

Measuring Riding Qualities. ROY. W. BROWN. *Soc. Automotive Engineers Journal*, Vol. 28, May 1931, p. 577-580.

An attempt is described to determine the many factors connected with riding comfort in an automobile. One of the principal factors is vibration; it can be assumed that the relative discomfort factor varies in proportion to the square of the accelerations at accelerations above 4 to 5 ft./sec./sec. Contact accelerometers have proved to be especially suitable for measuring vehicle vibrations and accelerations. Tests are reproduced and 11 references are cited. Ha (12.2)

Measuring the Behavior or Tall Buildings. D. CUSHMAN COYLE. *Engineering News Record*, Vol. 106, Feb. 19, 1931, pages 310-313.

A kind of seismograph is described developed to measure the stiffness of high buildings as expressed by the amplitude of vibrations caused by wind gusts; the oscillations are recorded, and curves taken for two New York buildings are reproduced. Ha. (12.2)

Tension Measurements in Blooms and Bars Cooled on One Side. (Spannungssung an einseitig abgeloeschten Knueppeln.) F. STAEBLEIN. *Krupp'sche Monatshefte,* Vol. 12, May 1931, pages 93-99.

When cooling a body in a liquid, the individual layers of the body are subject to tensions. Because of their magnitude, these tensions can no longer be assumed to be elastic and, for this reason, deform the body. The theory of determining these deformations and tensions is developed; an expression is derived which gives the relation of the tensions in the body to the deformations observed after planing off layer by layer. For 6 bars cooled on one side, the distribution of tension shows tensile stresses in the interior and compressive stresses on the exterior. Without subsequent treatment, the stresses are of the order of the elastic limit. They are reduced by annealing, even at 450° C., to about 1 to 2 kg./mm.^{2}. Ha. (12.2)

Antiaircraft-Gun Control. Part II: Description of the Sperry System. ROSWELL H. WARD. *Army Ordnance,* Vol. 12, July-August, 1931, pages 37-40.

On a few typical examples the component parts of the gun-control unit and of the methods of mechanical computation are described, and it is shown explicitly in which manner these mechanisms work together to automatically compute the gun angles and fuse settings required. The most important element in the Sperry system is the electrical system for transmitting the computed gun angles and fuse settings from computer to gun. A standardized, self-synchronous alternating current is used; this is described in detail. Ha. (12.2)

Instrumentation as a Means for Coordinating Chassis and Body Design. A. F. DENHAM. *S. A. E. Journal,* Dec. 1931, pages 442-446.

Information as to the mutual adaptability of a chassis and body can only be determined experimentally, and each car model is an individual problem. Coordination is difficult because the chassis usually must be developed far in advance of the time when the body is designed. Devices are described for subjecting cars and their major units to twisting stresses, and the application of instruments to measure and to integrate deflections are illustrated by examples. Remedies of troubles may be found by stiffening or introducing flexibility at certain points or by a redistribution of masses. Rubber mounting of engines and rubber body-shims change conditions and add to the difficulty of the problem. Experiences with some of the instruments described were reported in the discussion, and an instrument that has been developed for recording vibration amplitudes and frequencies on airplane instrument-boards was suggested for use on automobiles. (12.2)

Remarks on the Division of Scales for Rain-meters. (Bemerkungen zur Teilung der Mensuren fur Regenmesser.) H. OHRT. *Glass und Apparat,* Vol. 12, Aug. 1931, pages 9 and 121.

The amount of precipitation is usually given in mm.; the division on the vessel in which the precipitation is collected must therefore take into account the area of the collecting vessel. Ha. (12.2)

An Anemometer for a Study of Wind Gusts. R. H. SHERLOCK & M. B. STOUT. *Engineering Research Bulletin No. 20, University of Michigan.* 38 pages. July, 1931. Price $1.00.

This new type anemometer has been developed for a research project to determine the intensity, duration, and extent of wind gusts, and their effect on electric power lines. Existing anemometers possess inertia errors of unknown amounts which make them unsuitable for this work. This anemometer consists of a pressure plate and a magnetic transmitter and uses a twelve-element oscillograph as a recording device. Any pressure upon the plate modifies the size of the air-gap between two sets of iron laminations. This changes the inductance in a coil which surrounds one prong of the laminations and thus modifies the current flowing through the coil and produces a similar modification in the record of the oscillograph. The total movement of the pressure plate is only about .005 inches, so that the inertia errors are of an extremely small order of magnitude. With this instrument it is possible to record a large change in wind pressure so rapidly that within about one-tenth of a second all trace of the change has disappeared and the instrument is ready to receive a second change without interference in the record. 12 of these instruments are used simultaneously in the field, 7 of them being mounted on poles 50 feet high to obtain a horizontal section of the gusts, and five of them being mounted on a tower 250 feet high to obtain a vertical section of the gusts. The studies of wind gusts which are made possible through the development of this instrument will be of interest to those engaged in the design of tall buildings, large aircraft, and large marine vessels, as well as to designers of electric power transmission lines. (12.2)

The Idrac Apparatus for Recording the Velocity and Direction of Oceanic Currents. (Apparat Idrac zur Aufzeichnung der Geschwindigkeit und Richtung von Meeresstroemungen.) *Zeitschrift fuer Instrumentenkunde,* Vol. 50, Dec. 1930, pages 697-699.

The French current meter "Idrac" of the Société anonyme des anciens établissements Barbier, Bénard & Turenne, Paris, is reviewed. E.F. (12.2)

Rating and Testing of Diesel Engines. G. F. SWARTHOUT. *Motive Power,* Vol. 2, April 1931, pages 21-23.

A general discussion of the performance of Diesel engines and how to judge it from the indicator diagrams. It is advocated all industrial engines of any type should be rated on their maximum curve corrected to sea level barometric pressure and without accessories. Ha (12.2)

The Diagnostician in the Foundry. (Der Diagnostiker in der Giesserei.) H. HERTLEIN. *Giesserei mit Giesserei-Zeitung,* Vol. 18, Sept. 4, 1931, pages 715-716.

For economy in the foundry, the use of a diagnostician is recommended. This is an apparatus for recording periods of operation of machines; in this case, for molding machines for quantity production. It is illustrated as used in a certain molding process. Ha (12.2)

A New Dust Meter. (Ein neuer Staubmesser.) F. LOEWE, *Umschau,* Vol. 34, Sept. 13, 1930, pages 751-753.

Principles involved in the Konimeter of the Carl Zeiss Co., Jena. E.F. (12.2)

Graphical Methods for Quick Determination of Light and Sound Tracks in Various Media. (Graphische Methoden zur schnellen Bestimmung der Licht—und Schallwege in verschiedenen Medien.) R. BERGER. *Zeitschrift fuer Instrumentenkunde,* Vol. 51, March 1931, pages 157-159.

A new graphical method is outlined. Two illustrations. E.F. (12.2)

The Peculiarities of Lubrication Technique in Precision Instruments in the Light of the Latest Results of Research. (Die Besonderheiten der Schmiertechnik bei feinmechanischen Instrumenten unter Berucksichtigung neuerer Forschungsergebnisse.) CUYPER. *Zeitschrift fuer Instrumentenkunde,* Vol. 50, Nov. 1930, pages 660-661.

Refers to a paper presented before the Committee of the Verband fuer die Materialpruefungen der Technik, 1930. E.F. (12.2)

Novel Instruments for the Determination of Oceanic Currents. (Neuartige geräte zur Bestimmung von Meeresströmungen.) R. LEONHARDT. *Zeitschrift Verein Deutscher Ingenieure,* Vol. 75, Nov. 21, 1931, pages 1444-1446.

After a few remarks on oceanographic and hydrographic measurements an electric-instrument is described for measuring strength and direction of a current down to a depth of 100 m.; for depths above 100 m., a photographic current meter is used. For the details of construction the paper must be referred to. Ha (12.2)

Multipoint Gages. HARRY SHAW. *American Machinist,* Vol. 75, July 9, 1931, pages 43-46; July 23, 1931, pages 173-175, July 30, 1931, pages 208-211.

It is shown that a piece of work measured with a micrometer may not be actually circular in section and, in fact, be out of round to a degree detectable with the naked eye. Based on geometrical conditions, three-point gages are developed which detect and measure each irregularity in a circular form. The possibility of using more than three-point gages is explained and the design for such three and more point gages developed. Ha (12.2)

Measuring of Roll Pressures. FRANK H. BUHLMANN. *Paper presented before the Twenty-six Annual Convention of Association of Iron and Steel Electrical Engineers, June 1930. Iron & Steel Engineer,* Vol. 7, Nov. 1930, pages 532-35.

Describes apparatus developed for measuring roll pressures to facilitate design of bearings. Hydraulic method of Puppe is described. Inertia and delay in recording suddenly applied loads is the objection to this method. Author's method involves the use of telemeters (carbon pile resistances) which produce an unbalance in a Wheatstone bridge circuit proportional to the pressure, which is registered on a milliammeter or recorded on an oscillograph. WLC (12.2)

Measurement of Dust in Flue Gases. (Messung von Flugstaub in Rauchgasen.) E. ZIMMERMANN. *Zeitschrift Verein deutscher Ingenieure,* Vol. 75, April 18, 1931, pages 481-486.

Quantity and composition of the dust ejected by a chimney cannot be judged by observation of the smoke nor by automatic smoke meters but only by direct measurement of the dust. The experiences of the Berlin Electricity Works are related in the development of methods of measuring the quantity of dust in flowing flue gases. This is done mostly by diverting a partial current, the dust contained in it is caught and the amount of the sample of gas is measured. The amount of dust is found as increase of weight of the filter or, directly, by weighing of the substance itself, if possible. The main difficulty is to obtain the true average value. Of greatest importance is the arrangement of the suction, for the partial current, of which the wrong and right methods are shown in a diagram. Several constructions of suction heads are described, the proper mounting has to be found in each individual case by trial. The "cyclon" apparatus with externally arranged dust catcher gave very satisfactory results; tables for the evaluation are developed and the errors of this method determined. Ha (12.2)

Historical and Biographical (12.3)

History of the Circular Spirit Level. (Zur Geschichte der Dosenlibelle.) K. LUEDEMANN, *Zeitschrift für Instrumentenkunde,* Vol. 51, March 1931, pages 136-144.

At the end of 57 references, the author concludes that the circular spirit level was probably invented in 1777 by Johann Tobias Mayerson. EF (12.3)

History of Electrical Units. (Ueber die geschichtliche Entwicklung der elektrische Einheiten.) H. VON STEINWEHR. *Zeitschrift fuer Instrumentenkunde,* Vol. 50, Jan. 1930, pages 19-32.

Historical review, with 14 references. E.F. (12.3)

Joseph Black's Micro-Balance. (Joseph Blacks Mikrowaage mit Reiterversatz.) M. SPETER, *Zeitschrift fuer Instrumentenkunde,* Vol. 50, March 1930, pages 204-206.

Historical facts on the merits of Dr. Joseph Black who developed a very sensitive balance before 1800. E.F. (12.3)

Economic (12.5)

Economic Importance of Measurements in Glass-Plant Operation with Particular Regard to Coal and Gas Economy. (Wirtschaftliche Bedenburg des Messwesens in enien Glasshuttenbetriebe mit besonderer Berucksichtigung der Kohle- und Gaswirtschaft.) W. BUESSING. *Glasstechnische Berichte,* Vol. 9, July 1931, pages 402-407.

The author discusses in a general way the advantages which can be obtained by using measuring and recording instruments in all processes of glass manufacture; testing of fuel, weighing of fuels and materials, quantity and temperature of gases, control of melting furnaces, etc. The costs for the instruments will be only a small part of the savings resulting in such supervision; in a concrete case the reduction in consumption of coal for each kilogram of raw glass melted amounted to 40%, while the investment in instruments amounted to only 15% of the saving. Ha (12.5)

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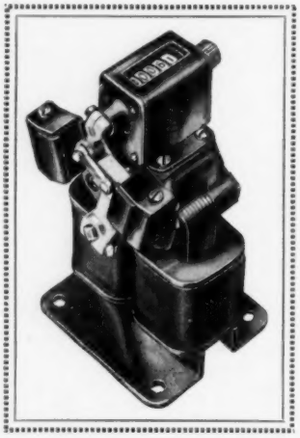

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THE BRISTOL COMPANY
WATERBURY CONNECTICUT

Branch Offices: Akron, Birmingham, Boston, Chicago, Denver, Detroit, Los Angeles, New York, Pittsburgh, Philadelphia, St. Louis, San Francisco

BRISTOL'S
UNDIVIDED RESPONSIBILITY!

BRISTOL'S Automatic Process Control Equipment is so complete, comprehensive and diversified in design, type, and application that BRISTOL is in the favorable position of prescribing the best solution for *your* control problems.

In cooperating with you BRISTOL'S Engineers investigate and interpret your particular conditions and needs; design the correct control methods, equipment, and systems; coordinate these with your plant routine; and assume undivided responsibility for continually satisfactory performance.

***Typical of the hundreds of actual and potential applications of BRISTOL'S Automatic Process Control in wide use today are the following:**

Automatic Cycle Control in Vulcanization of Automobile Rubber Tires and Tubes. Bulletin 386-R.
Automatic Cycle Control in Processing and Preserving of Foods. Bulletin 386-F.
Double Unit Electric Control for Automatically Holding Pasteurizing Temperatures within ½ deg. Fahr. or less. Bulletin 3200.
Automatic Control of Hot Blast Temperatures in Blast Furnace Operation. Bulletin 372.
Recording and Controlling Equipment for Automatically Controlling Humidity in the Saturation of Natural Gas. Bulletin 962-A.
Automatic Temperature Control of Seal Water in Direct Steam Heated Gas Holders and Circulating Water Heated Gas Holders. Bulletin 960-E.
Automatic Operation Control of Producer Gas Machines. Bulletin 961-A1.
BRISTOL also makes a complete line of instruments for indicating, recording, and controlling pressure, vacuum, temperature, voltage, current, power, frequency, motion, time, speed, humidity, liquid level, flow; as well as electric motor operated and diaphragm motor operated valves for process control.

TRADE MARK
BRISTOL'S *Automatic Process Control*
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